WRS
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(SW2)

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March 24, 2004

VIA Next Day UPS

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Re: Consent Order No. 31-07-02
Compliance Program Sections:
IV(4.1)(d.)(1.) and II(2.2) and II(2.4)
Secondary Containment Work Plan Supplemental Submission #3
Williamsburg Receiving & Storage
ISE Project # 02633061-34E

Gentlemen:

This communication is intended to provide Michigan Department of Environmental Quality (DEQ) staff the Work Plan Supplement required pursuant to the referenced Consent Order (CO), the February 24, 2004 correspondence from Janice Lee Heuer of MDEQ (received: March 11, 2004) and the February 20, 2004 meeting that Ms. Heuer's correspondence references. This supplement is also prepared in consideration of the March 15, 2004 meeting held at MDEQ Water Division Headquarters between a multidisciplinary group of MDEQ Staff and Food Processing Industry Stakeholders. This submission is the third supplement to the Secondary Containment Work Plan dated February 12, 2003 and is submitted in accordance with requirements detailed in Sections 2.2 and 2.4 of the CO.

The referenced MDEQ letter (MDEQ Review) provided a summary of the February 20th meeting at MDEQ's Cadillac District office between MDEQ Staff and representatives of Williamsburg Receiving and Storage (WRS). The MDEQ Review summarizes matters discussed beyond the scope of the February, 2003 Secondary Containment Work Plan and Supplements. For purposes of this communication only those matters relevant to the referenced CO elements are summarized below:

1. Construction Details for Interstitial Volume Monitoring
2. Material Specifications for Secondary Containment System Structural Components
3. Geomembrane Installation and Construction Quality Assurance Plans
4. Management Plan for Precipitation and Ballast Water above Polyethylene Cover
5. Management Plan for Hydrostatic Test Water
6. Field Test Failure Contingency Plan
7. Justification for Proposed Part 5 Compliance Schedule

The above listed Work Plan and design elements are in general agreement with the meeting minutes recorded by the author at the February 2004 meeting. This submittal is formatted in accordance with Section V of the referenced CO and those headings below that are formatted in upper case relate to the MDEQ Review elements listed immediately above. Users of this submittal are encouraged to contact the author with any questions they may have or any further requests for supplemental details related to the above listed MDEQ Review elements.

Secondary Containment System Overview and Development

Long term plans for brine storage and mixing operations include relocation from outdoor to indoor areas as WRS represented at the September 3, 2003 meeting with MDEQ Staff at WRS. The February 2003 Work Plan provided an outline for development of Secondary Containment Systems (SCS) for outdoor storage areas. Conceptual plans for SCS for brining pits at WRS have been provided to MDEQ District Staff in Cadillac on October 13, 2003 and February 20, 2004. The conceptual plans presented have evolved through various design, construction and operational improvements forwarded by design professionals retained by WRS and by MDEQ Staff.

The proposed SCS is a variant of typical in-ground cherry brining vessels constructed at receiving stations and processing plants throughout Michigan. The technology currently utilized for brining pits consists of a polyvinyl chloride (PVC) liner placed into an excavation prepared to receive the PVC liner. Within this lined excavation, brine and sweet cherries are placed. Upon placement of the cherries and brining solution, the pit is covered with a 6-mil (0.006-inch thick) polyethylene cover to seal the vessel and secure it from the elements and maintain a sanitary condition within the brining vessel.

The WRS conceptual proposal includes a double liner in-ground system with interstitial monitoring for surveillance. The interstitial volume is proposed to include a structural geotextile and surveillance/monitoring probes. The February 20, 2004 meeting provided an opportunity to demonstrate the proposed SCS through the use of a bench scale model. The March 15, 2004 MDEQ Part 5 Guidance Task Force (P5TF) meeting provided useful comment regarding the proposed SCS, including:

- Acceptability of the proposed 40 mil PVC flexible membrane liner (FML) materials
- Recognition that the 6 mil Polyethylene cover is not a functional element of the SCS
- Acceptability of the proposed interstitial volume surveillance technique
- Acceptable alternatives to the proposed interstitial volume surveillance technique
- Guidelines for the material specification of the Geotextile interstitial structural material

CONSTRUCTION DETAILS FOR INTERSTITIAL VOLUME MONITORING

Figure 1 (attached) provides a detail of the typical SCS construction in plan and section views. Figure 2 provides a detail depicting completion of the surveillance system and its termination at the surface. Figure 3 depicts typical deployment strategies for the interstitial surveillance sensors. These show uniform, random and biased deployment strategies for the conductivity based sensor array. Figure 4 provides a depiction of the alternative surveillance technique deemed acceptable by the P5TF at the March 15th meeting.

MATERIAL SPECIFICATIONS FOR PROPOSED SCS FUNCTIONAL COMPONENTS

Geomembranes

Material specifications for each of the structural members comprising the SCS are provided as attachments. These are manufacturer-provided specifications from Environmental Protection, Inc. (EPI) for liners and Gundle/GSE (GSE) for interstitial geotextile. The specific materials of construction proposed are:

- 40 mil PVC Geomembrane Specifications (EPI)
- Geonet (HyperNet #XL4000N004) Geomembrane (GSE)

Also included is a GSE material compatibility chart which demonstrates that the polyethylene geotextile proposed for the interstitial structural member is compatible with saturated sodium chloride, calcium chloride and sodium sulfide solutions. The cherry brining solution has been previously shown to be approximately 4% (by weight) solution of sodium and calcium chloride.

As discussed at the P5TF meeting, the 6-mil polyethylene covering membrane is not a functional component of the SCS. It serves sanitary and other process purposes unrelated to containment. As such, no specifications are provided in addition to those previously supplied. The polyethylene cover specifications will meet applicable State and Federal regulations related to its use in the food processing industry.

Interstitial Surveillance Sensor Components

Note that the prototype sensor device displayed at the March 15th meeting in Lansing is sealed in epoxy resin within a PVC container (pot). The only elements of the sensor exposed in the environment of the interstitial volume are two (2) stainless steel electrical contacts. Electrical connection to the surface monitoring data processor is via Category 5 telecommunications cable. The outer insulator material is polyethylene.

The material specifications for the alternate surveillance system tubing are also attached. The field-scale prototype will utilize both ¼-inch and $^3/_8$-inch diameter polyethylene tubing to evaluate the most suitable diameter. To the fullest extent practical, tubing will be continuous, without fittings, seams or field splices throughout its length. When field joining or splicing is required, manufacturer-recommended jointing techniques and fittings will be utilized. Minimum collapse pressure rating will be 20 pounds per square inch (psi). Minimum working pressure rating will be 50 psi. Polyethylene tubing commonly available has typical burst pressure ratings in excess of 300 psi.

GEOMEMBRANE INSTALLATION AND CONSTRUCTION QUALITY ASSURANCE PLANS

Brining pit excavation surface preparation (when applicable), Liner and Geonet installation quality assurance and quality control (QA/QC) will comply with each Geomembrane material manufacturer's requirements and recommendations. These specific requirements and procedures are included within the attachments. Separate QA/QC manuals are provided by EPI and GSE. These manuals include information on preparation of sub-grade, geomembrane handling and storage, field seaming/repairing, placement and construction quality assurance documentation.

Upon completion of construction of field-scale prototypes using the original and the alternate interstitial volume surveillance methods (see contingency plan below), the manufacturers' QA/QC manuals will be edited into one (1) document with instructions specific to proper construction of additional SCS units. It is understood that this prototype construction will represent the first such installation of such a SCS. As such, actual installation practices will be documented.

Procedures or requirements contained within the manufacturers' manuals which are determined to be inapplicable or unnecessary will be eliminated from the initial DRAFT Construction QA/QC Manual. Similarly, site-specific variations or additions to the manufacturers' recommended practices will be incorporated, as needed. Each of the original manufacturers' QA/QC manuals will be cited within the DRAFT Construction QA/QC Manual and incorporated by reference. At the completion of the field-scale trial period, the DRAFT Construction QA/QA Manual will undergo final editing.

In addition, for each SCS constructed, record drawings will be assembled and preserved to document "AS-BUILT" conditions of the brining pit excavation or the secondary containment FML, whichever is appropriate, depending upon if the SCS is assembled from an existing brining pit or from a new excavation.

MANAGEMENT PLAN FOR HYDROSTATIC TEST WATERS, BALLAST AND PRECIPITATION

Hydrostatic Testing Water

Hydrostatic testing waters, when generated, will be produced from the potable water supply or from accumulated precipitation stored in accordance with the facility SWP3. When hydrostatic testing of a FML is complete, this water pumped into another pit for further use in hydrostatic testing of other FMLs. When no longer required for testing the hydrostatic test water will be properly characterized and managed in accordance with Part 121 of NREPA.

Ballast and Precipitation

Part 5 Rules indicate that the ballast and precipitation waters above the cover are managed such that the minimum containment volume is maintained at all times. Regular surveillance of the freeboard conditions of each pit will be conducted. Maximum free board required for compliance with Part 5 is estimated for winter months (October through March) by adding the annual average snow-water equivalent for the period (12.16 inches) to the 25 year-24 hour storm event (3.89 inches). This is approximately 16 inches, based upon information from the State Climatologist's Office.

All ballast waters utilized will be produced from the facility potable water supply. Ballast water and precipitation accumulated above the pit cover will be commingled. Therefore, all ballast and precipitation waters generated in the management of freeboard requirements will be handled and managed in accordance with the facility SWP3. The SWP3 considers that all accumulated precipitation will be characterized in accordance with Part 31 of NREPA to assure compliance with this part. Any ballast and precipitation water determined to be a wastewater (pursuant to Part 22 Rules) will be managed in accordance with Part 121 of NREPA, unless the existing Wastewater Discharge Permit is modified to allow an alternate disposition.

FIELD TEST FAILURE CONTINGENCY PLAN

Background

As cited in prior Work Plans and Supplements, WRS maintains long-term plans to relocated outdoor brining operations to interior and utilize above-ground fiberglass tanks. The execution of this long-term plan is on-going. At present, preliminary floor-plans have been drawn for cherry brining tank systems and locations have been identified for indoor operations in conjunction with other business growth plans. Tank vendors have been identified and first-order estimates prepared for financial planning. Recent developments suggest that new sources of competitive financing may become available soon through a State pollution prevention loan program.

Single layer FML brining pits have been used in the industry for decades. This long record of performance suggests that they are quite reliable and maintain their inventories. Research has indicated that the dual layer FML SCS approach has no operating history. It is believed that a similar degree of success will be realized using the proposed SCS approach, especially in consideration of the enhanced surveillance that brining pit operations will now receive in operation under Part 5 Rules.

Due to the lack of operating history for the proposed SCS approach (and other factors cited below), it is believed that a significant period of time will have to elapse in order to generate SCS reliability data and develop an operating history of various SCS alternatives. During this period, long-term planning will continue and the goal of indoor brining operations will remain among the most viable of contingencies. Alternate contingency plans may include relocating operations outside of Michigan, if the proposed SCS fails to perform adequately, or if the economics of construction, operation and maintenance for SCS render business relocation the most viable of options.

Proposed Modification of Part 5 Compliance Work Plan for Contingency Evaluation

The MDEQ P5TF deemed that an alternate surveillance method, if properly constructed and operated, would constitute an acceptable interstitial monitoring design for the dual FML SCS originally proposed under the WRS Part 5 Compliance Work Plan. This alternate method may provide a SCS that is of lower capital cost and simpler operation than the dual FML SCS proposed in the WRS Part 5 Compliance Work Plan. It is proposed that the Work Plan be modified in light of the P5TF guidance to allow evaluation of this alternative surveillance method during planned field-scale trials. Approval of this proposed modification would foster development of yet additional contingency plans by promoting field evaluation of the alternative surveillance technique.

The proposed modification of the Work Plan includes revision to the implementation schedule for the original SCS proposed. The original proposal included installation of nine (9) of the originally proposed SCS units by July 1, 2004 with one (1) unit installed by April 30, 2004. The revised schedule for deployment of field-scale testing proposed decreases the number of units installed in 2004 to eight (8), with an increase in the number of units installed by April 30th. One (1) of these initial units would utilize the surveillance technique originally proposed and demonstrated by the bench-scale model. The remaining initial unit would be equipped with the alternate surveillance system discussed at the P5TF meeting on March 15th.

Of the remaining SCS units proposed for installation in 2004, three (3) each of the initial and alternate surveillance systems would be installed in the remaining six (6) field-scale demonstration units. This proposed revision to the Work Plan allows a "side-by-side" comparison of surveillance techniques during field-scale technology demonstrations. The alternate surveillance operation is described in greater detail below. Material specifications for the tubing are discussed above.

Alternate Surveillance System Operation

The alternate interstitial surveillance system deeded acceptable by the P5TF is analogous in operation and similar in construction to leachate collection systems utilized in sanitary landfill design. The alternate surveillance system consists of tubing inserted within the interstitial volume below the Geonet. The tubing is composed of polyethylene and is placed within the sump area and any other depressions of consequence above the secondary containment FLM liner. The surface termination of the polyethylene tubing is routed to a convenient location accessible to monitoring personnel.

The alternate surveillance system operates manually. Suction is applied to the above ground terminal end of the tubing via vacuum pump. If liquid is introduced to the interstitial volume, the Geonet conveys the liquid by gravity drainage to the sump area or other depressions of consequence upon the surface of the secondary containment FML. The vacuum applied to the polyethylene tubing will cause fluid accumulations within the sump/depression areas to be transmitted to the surface where the volume of the liquid and its conductivity are determined. If necessary the recovered liquid can be submitted for laboratory analysis of chloride concentration. If there is no liquid within the interstitial volume, no liquid will be produced at the surface upon application of vacuum to the tubing.

Tubing functionality and integrity are assured by first pressurizing the tubing to establish that it is free of obstructions. Maximum pressure anticipated for integrity testing is essentially equivalent to the hydrostatic head caused by a full brining pit. This is approximately 5 to 7 pounds per square inch and represents the condition of a complete failure of the primary FML and transfer of its contents to the secondary FML. Pressure noted in excess of this nominal level should be indicative of an obstruction of the tubing. In absence of any liquids within the interstitial volume, which represents a fully functional SCS, the anticipated pressure observed at the monitoring terminal end of tubing results only from the frictional resistance to flow in the tubing.

Similarly, the maximum vacuum anticipated to produce any liquid within the interstitial volume is simply the vacuum required to lift brine approximately 15 feet. Observation of this vacuum would represent the condition of minimal liquid within the interstitial volume. To circumvent the possible loss of monitoring apparatus due to plugging, the tubing functionality will be assured by installation of tubing pairs for redundancy.

Other than the mechanics of surveillance, the proposed alternate SCS would be operated in the same manner as the system previously proposed. The responses to observed SCS system or component failures are the same.

JUSTIFICATION FOR PROPOSED PART 5 COMPLIANCE SCHEDULE

It has been noted during various meetings and communications with MDEQ Staff that WRS' proposal for Part 5 compliance is the only known, documented effort within Michigan's cherry brining industry to establish compliance with Part 5 operational and technical requirements. Through WRS' efforts MDEQ Staff have recognized that the proposed methods of construction and operation are unique and untested. Yet, the proposals tendered for bringing pit SCS represent the continuation of cherry brining practices standard through the industry coupled with improvements in materials and technology.

Contingent alternative approaches to the proposed SCS present considerable challenges. The proven technical and regulatory solutions for compliance (indoor storage-aboveground tanks) are so capital intensive that relocation outside of Michigan may become the most feasible alternative. This is especially true in light of two (2) successive years of dire economic conditions within the industry resulting from low-yield sweet cherry harvests. Also of significant consequence to WRS is the disparity in compliance within the industry with regard to Part 5 rules. This presents an unbalanced marketplace in which WRS must compete with a disadvantaged operating cost structure. No other cherry brining operation has experienced the development or implementation costs associated with technical and operational initiatives that demonstrate to MDEQ compliance with Part 5 rules.

Aside from rationale related to equitable market conditions, technical rationale exist for the phased implementation approach for SCS units proposed by WRS in its Part 5 Compliance Work Plan. All parties involved in development and review of WRS' Part 5 Compliance Work Plan recognize that the proposed SCS and alternative SCS approaches are untested. So stark is this reality that MDEQ requires contingencies are to be proposed in advance of deployment so that this potential outcome be addressed prospectively and Part 5 compliance efforts be maintained. The proposed systems and their proposed phase-in represent significant investment in capital and human resources with no guarantee of success.

The proposed phase-in (as modified above) provides for approximately 54 cycles of SCS use and operation (8 cycles in year #1 + 18 cycles in year #2 + 27 cycles in year #3 = 54 total cycles) during the implementation schedule. Only the SCS units installed in first year will experience three (3) cycles of use and operation. Another 10 units from year #2 will experience two (2) cycles. Cycling the SCS through reuse is the only means by which long-term operating history

can be established. Also, It is anticipated that construction and operation experiences during each successive year will yield further development and improvements for each SCS approach. This evolution in improvement is consistent with design and development experiences shared by MDEQ and WRS' design professionals to date.

The proposed phase-in plan provides a sound balance between the need to implement secondary containment and the need to mitigate significant risks associated with untried techniques. The risk of failure of the proposed SCS units should be given significant weight in any decision to balance compliance efforts with capital investment. Should untested techniques fail to perform as conceived and designed, residual working capital will be needed to exercise contingency options.

Therefore the proposed phase-in strategy provides an optimum approach that serves to ensure that the first and only documented Part 5 compliance initiative in the cherry brining industry is successful. Such a success should in turn serve to foster Part 5 compliance throughout the industry. Through this proposed phase-in process the most practical approaches for secondary containment will be identified. Success will likely be disseminated throughout the MDEQ and regulated community alike. Knowledge of capital and operational cost along with MDEQ acceptance will diminish the risk perceived by non-compliant brining operations and foster additional investment into compliant facilities.

Please call me at (231) 933-4041 if you have any questions. I look forward to hearing from you.

Respectfully submitted,
INLAND SEAS ENGINEERING, INC.

Andrew Smits, P.E.
Environmental Engineering
Department Manager

cc: Mr. Christopher Hubbell
Mr. Joseph E. Quandt
Mr. Edgar Roy III
Mr. Richard D. Rusz- MDEQ/WD- Lansing

enc.

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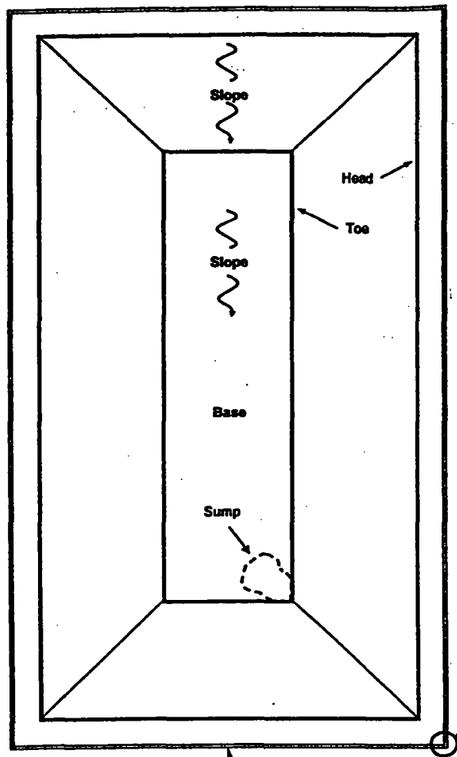
FIGURES

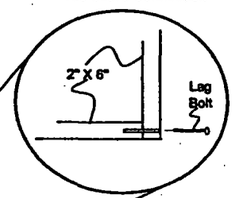
CHERRY BRINING PIT
SECONDARY CONTAINMENT SYSTEM SCHEMATIC

Capacity (nominal) : 190,000 pounds cherries
19,000 gallons brine

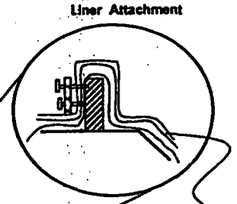
PLAN VIEW



Tac-board Connection

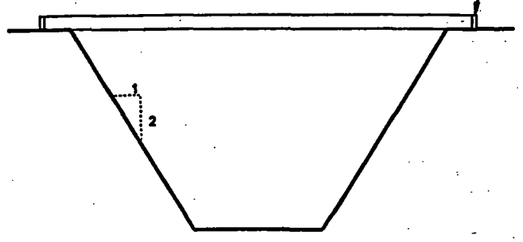


Liner Attachment

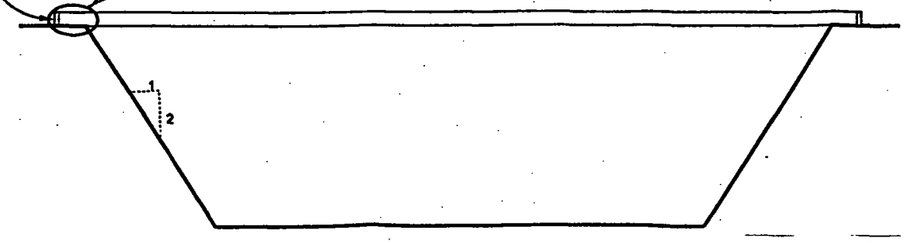


Two 40-mil PVC Liners w/ Interstitial GeoNet

Tack Boards



TRANSVERSE PROFILE



LONGITUDINAL PROFILE

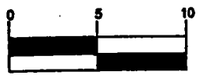
GeoNet Specifications

Product:	HyperNet XL4000N004
Transmissivity :	9.66 GPM / Ft
Thickness :	0.20-inch
Density:	0.94 grams / cc
Tensile Strength:	45 lbs. Per inch
Roll Width:	15 feet
Roll Length:	300 feet
Roll Area:	4,500 sq. ft.

Liner Specifications

W = 35 feet L = 58 feet
From 72-inch roll stock, seams heat welded
2 Layers - each 40 mil PVC

Thickness (+/- 5%)	:	0.040-inch	ASTM D-1593
Specific Gravity (min)	:	1.2	ASTMD-792
100% Modulus (psi, min)	:	1000	ASTMD-882
(lb/in-width, min)	:	33	
Tensile (psi, min)	:	2400	ASTMD-882
(lb/in-width, min)	:	92	
Elongation at Break (% min)	:	350	ASTMD-882
Graves Tear (lb/in, min)	:	10	ASTMD-1004
Impact cold crack	:	-20	
Dimensional Stability (% change, max)	:	4	ASTMD-1204 (212°F/15 min)
Water Extraction (%, max)	:	0.35	ASTMD-3083
Volatile Loss (%, max)	:	0.9	ASTMD-1203 (A)
Hydrostatic Resistance (psi, min	:	82	ASTMD-751 (A)
Factory Fabricated Seams			
Peel Strength (lb/in, min)	:	15	ASTMD-882
Shear Strength (lb/in, min)	:	73.6	ASTMD-882



SCALE IN FEET

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REVISIONS				
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			FIELD BY :	AJS
			CHECKED BY :	AJS
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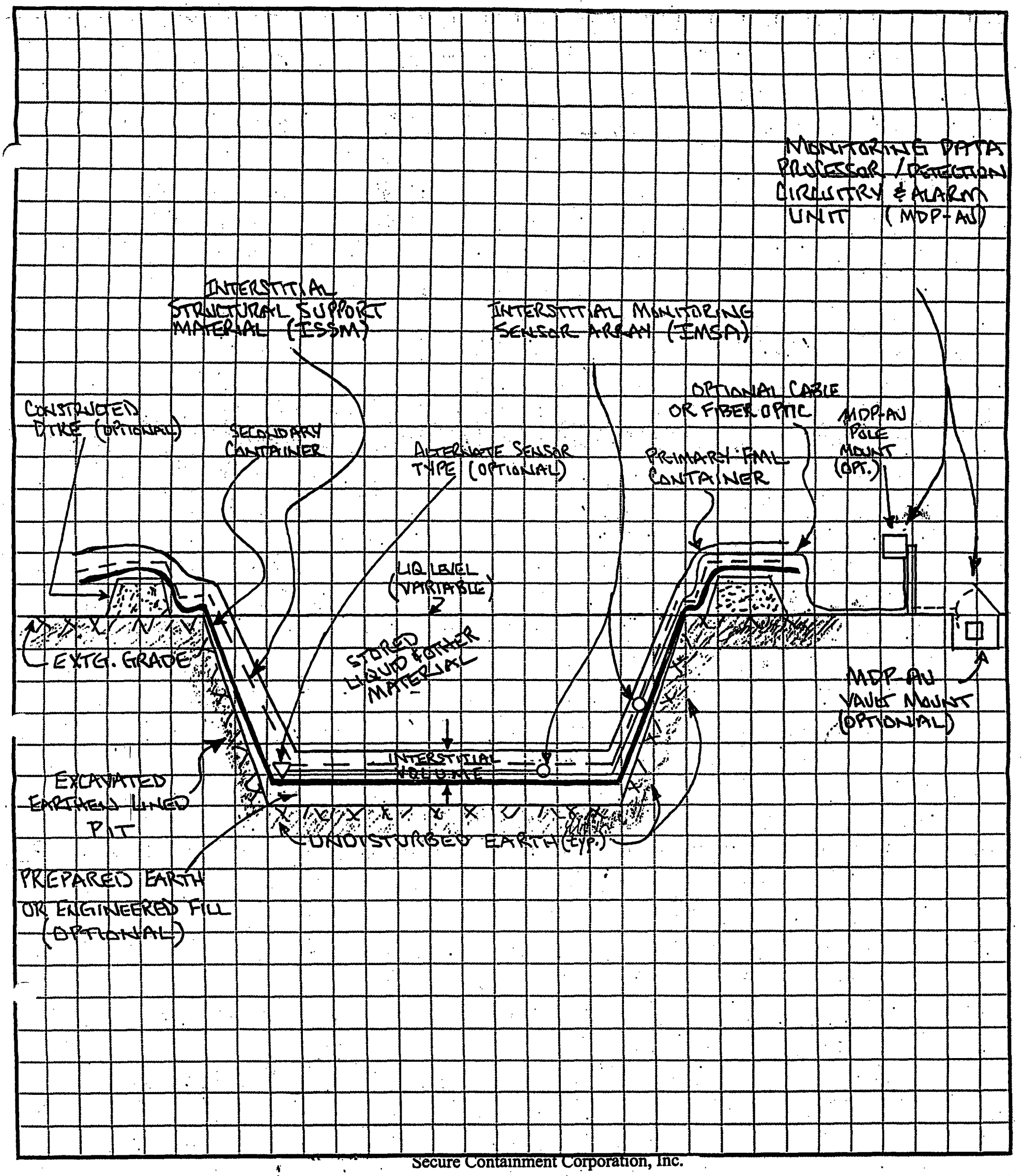
			DATE :	3/20/2004
			PROJECT # :	02633061-34E
			FIGURE # :	FIGURE 1

FIGURE 2

TYPICAL CONSTRUCTION SCHEMATIC DIAGRAM
SECONDARY CONTAINMENT SYSTEM
LEAK DETECTION COMPONENTS

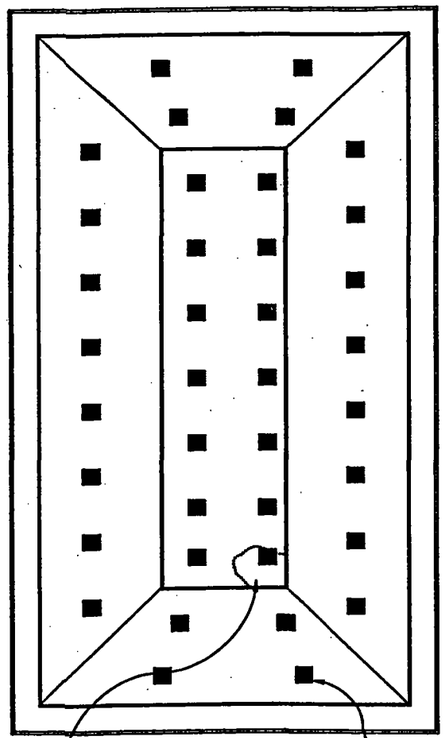


Secure Containment Corporation, Inc.

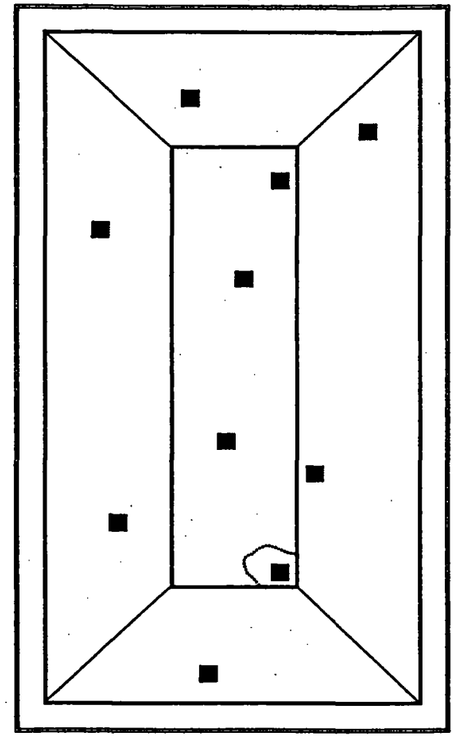
PATENT PENDING

CHERRY BRINING PIT
SECONDARY CONTAINMENT SYSTEM SCHEMATIC
INTERSTITIAL MONITORING / SURVEILLANCE SENSOR ARRAY OPTIONS

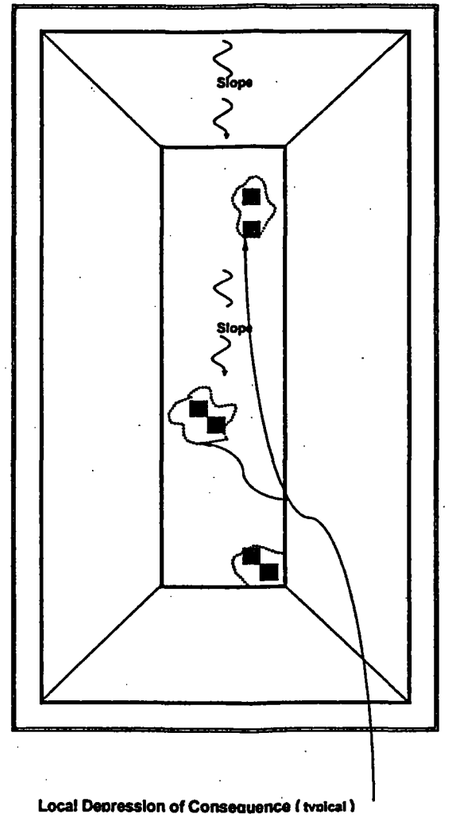
UNIFORM SENSOR DEPLOYMENT



RANDOM SENSOR DEPLOYMENT



BIASED SENSOR DEPLOYMENT



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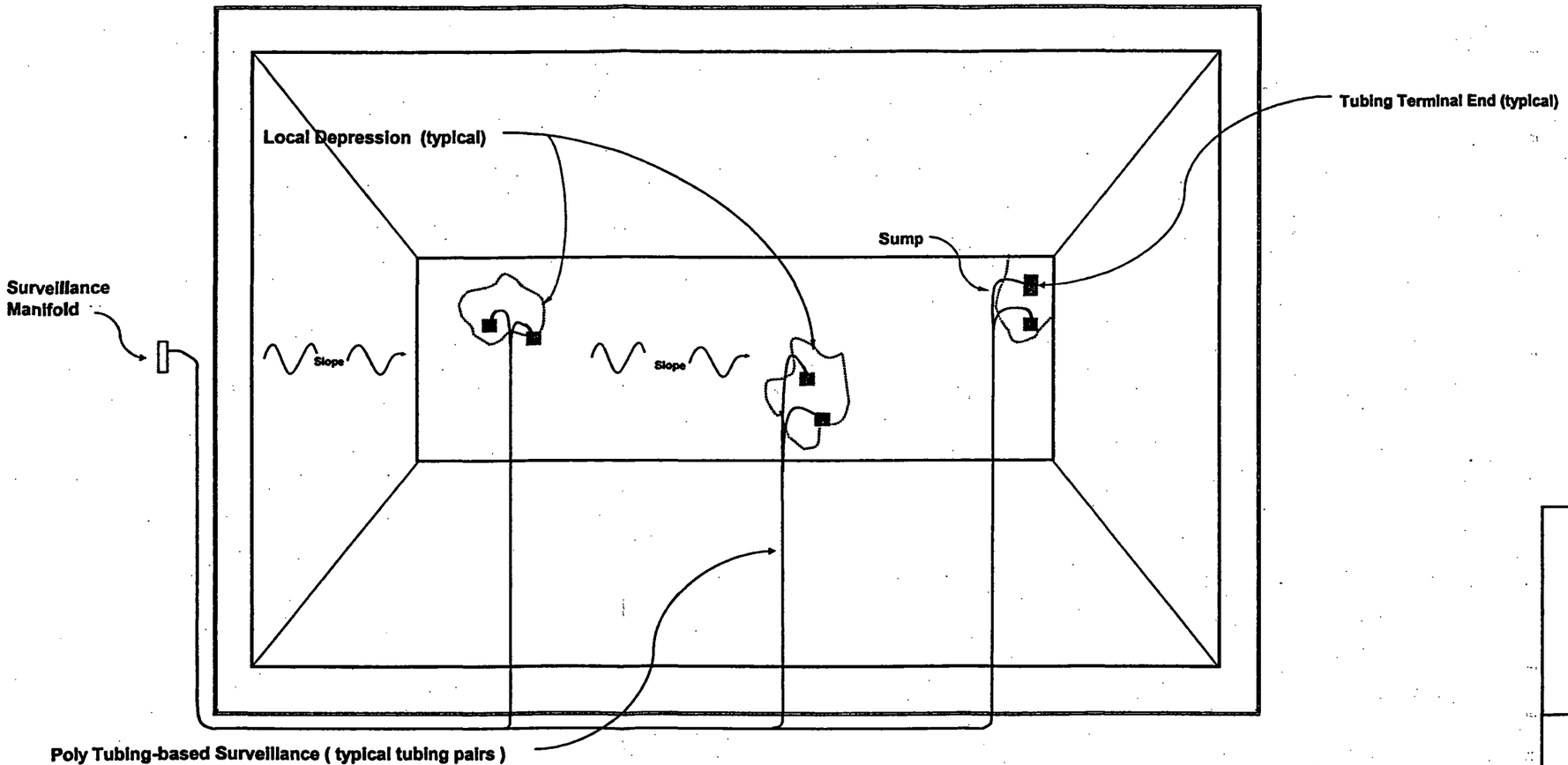
			SCALE :	See Dimensions
			DATE :	3/20/2004
			PROJECT # :	02833061-34E
			FIGURE # :	**FIGURE 3**

CHERRY BRINING PIT
SECONDARY CONTAINMENT SYSTEM SCHEMATIC
ALTERNATIVE INTERSTITIAL MONITORING / SURVEILLANCE OPTION
MDEQ Part 5 GUIDANCE TASK FORCE



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			DATE :	3/20/2004
			PROJECT # :	02633061-34E
			FIGURE # :	**FIGURE 4**

GEOMEMBRANE MANUFACTURER'S MATERIAL SPECIFICATIONS

SOLUTIONS

ENVIRONMENTAL PROTECTION, INC.

40 mil PVC Geomembrane Specifications

TYPICAL APPLICATIONS:

- Landfill Liners
- Landfill Closures
- Reservoirs
- Sewage Lagoons
- Soil Remediation
- Industrial Waste Ponds

PVC liners fabricated by EPI are a single-ply construction with Polyvinyl Chloride as the principle polymer. Only first quality virgin resins are used and all materials meet or exceed the PVC Geomembrane Institute PGI-1.1.03 Specification, which replaces PGI-1.1.97 for flexible membrane liners.

EPI utilizes statistical process control (SPC) to ensure the integrity of each panel produced. Samples from actual factory seams are removed during the welding process for a rigorous, proven testing procedure that assures you of the highest quality factory-fabricated PVC geomembranes available.

PVC Liners are fabricated by EPI in panels, accordion-folded in both directions, and packaged for shipment to your site for quick, easy installation to save you time and money.

Thickness ± 5%	ASTM D-5199	.040"
Specific Gravity (min)	ASTM D-792	1.20
Tensile (lb/in-width, min)	ASTM D-882	97
Elongation at Break (% min)	ASTM D-882	430
Modulus (lb/in-width, min)	ASTM D-882	40
Tear Resistance (lb/in, min)	ASTM D-1004	10
Resistance to Soil Burial (% change, max)	ASTM G-160	
1. Breaking Factor		5
2. Elongation At Break		20
3. Modulus at 100% Elongation		20
Impact Cold Crack (°C)	ASTM D-1790	-29
Dimensional Stability (% change, max)	ASTM D-1204 (212°F/15 min.)	3
Water Extraction (%,max)	ASTM D-1239	0.2
Volatile Loss (%, max)	ASTM D-1203(A)	0.5
Hydrostatic Resistance (psi, min)	ASTM D-751(A)	120
Factory Fabricated Seams:		
Peel Strength (lbs/in, min)	ASTM D-882	15
Shear Strength (lbs/in, min)	ASTM D-882	77.6

These data are based on tests believed to be reliable. However, these are laboratory tests that may not simulate actual use conditions. They are provided for your informational purposes only. No warranty, express or implied, including any other further warranty of fitness for a particular purpose or merchantability, is made by this promotional literature

9939 US-131 South
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SOLUTIONS

ENVIRONMENTAL PROTECTION, INC.

Potable Water Liner

EPI now has available 40 Mil thick white potable water grade liner for all your pure water needs.

This material is specially formulated to meet the requirements of The National Sanitation Foundation (NSF Standard 61) for drinking water additives and is so certified. This material has also been approved for use with:

- Drinking water
- Potable process water
- Brine solution

Thickness ± 5%	ASTM D-1593	.040"
Specific Gravity (min)	ASTM D-792	1.20
100% Modulus (psi, min)	ASTM D-882	1000
(lb/in-width, min)		33
Tensile (psi, min)	ASTM D-882	2400
(lb/in-width, min)		92
Elongation at Break (% min)	ASTM D-882	350
Graves Tear (lb/in, min)	ASTM D-1004	10
Impact Cold Crack (°C)	ASTM D-1790	-20
Dimensional Stability	ASTM D-1204	
(% change, max)	(212°F/15 min.)	4
Water Extraction (%,max)	ASTM D-3083	0.35
Volatile Loss (%, max)	ASTM D-1203(A)	0.9
Hydrostatic Resistance	ASTM D-751(A)	
(psi, min)		82
Factory Fabricated Seams:		
Peel Strength (lbs/in, min)	ASTM D-882	15
Shear Strength (lbs/in, min)	ASTM D-882	73.6

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INTRODUCTION TO SAMPLE SPECIFICATIONS

GSE is the world leader in providing geosynthetic lining solutions, products and services to satisfy the needs of domestic and international and public and private companies engaged in waste management, wastewater treatment, mining, aquaculture and other industrial activities.

Gundle/SLT Environmental, Inc., the parent company of GSE, is a corporation formed in July 1995 by the merger of Gundle Environmental Systems, Inc. and SLT Environmental, Inc. It is listed on the New York Stock Exchange under the symbol "GSE". The company's headquarters are located in Houston, Texas. GSE's Gundseal GCL clay lining manufacturing plant is located in Spearfish, South Dakota, USA. GSE's non-woven geotextile manufacturing pant is located in Kingstree, South Carolina, USA. Other manufacturing facilities are located in Germany, the United Kingdom, Canada, Thailand and Egypt.

SECTION 02621

GEONET DRAINAGE LAYER

PART 1: GENERAL

1.01 SECTION INCLUDES

A. Specifications and guidelines for MANUFACTURING and INSTALLING geonet.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. D 1238-01 Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
   2. D 1505-98 Standard Test Method for Density of Plastics by the Density-Gradient Technique
   3. D 1603-94 Standard Test Method for Carbon Black in Olefin Plastics
   4. D 4716-00 Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
   5. D 5035-95 Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
   6. D 5199-99 Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes

B. Relevant publications from the Environmental Protection Agency (EPA):
   1. Daniel, D.E. and R.M. Koerner, (1993), *Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities,* EPA/600/R-93/182.

1.03 DEFINITIONS

A. Construction Quality Assurance Consultant (CONSULTANT) - Party, independent from MANUFACTURER and INSTALLER that is responsible for observing and documenting activities related to quality assurance during the lining system construction.

B. ENGINEER- The individual or firm responsible for the design and preparation of the project's Contract Drawings and Specifications.

C. Geonet Manufacturer (MANUFACTURER) - The party responsible for manufacturing the geonet rolls.

D. Geosynthetic Quality Assurance Laboratory (TESTING LABORATORY)- Party, independent from the MANUFACTURER and INSTALLER, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing, usually under the direction of the OWNER.

E. INSTALLER- Party responsible for field handling, transporting, storing and deploying the geonet.
F. Lot- A quantity of resin (usually the capacity of one rail car) used to manufacture polyethylene geonet rolls. The finished rolls will be identified by a roll number traceable to the resin lot.

1.04 QUALIFICATIONS

A. MANUFACTURER
1. Geonet shall be manufactured by the following:
a. GSE Lining Technology, Inc.
b. approved equal
2. MANUFACTURER shall have manufactured a minimum of 10,000,000 square feet of polyethylene geonet material during the last year.

B. INSTALLER
1. Installation shall be performed by one of the following installation companies (or approved equal):
a. GSE Lining Technology, Inc.
b. GSE Approved Dealer/ Installer
2. INSTALLER shall have installed a minimum of [ ] square feet of geonet in the last [ ] years.
3. INSTALLER shall have worked in a similar capacity on at least [ ] projects similar in complexity to the project described in the contract documents, and with in at least [ ] square feet of geonet installation on each project.
4. The Installation Supervisor shall have worked in a similar capacity on projects similar in size and complexity to the project described in the Contract Documents.

1.05 MATERIAL LABELING, DELIVERY, STORAGE AND HANDLING

A. Labeling- Each roll of geonet delivered to the site shall be labeled by the MANUFACTURER. The label will identify:
1. manufacturer's name
2. product identification
3. length
4. width
5. roll number

B. Delivery- Rolls of geonet will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.
C. Storage- The on-site storage location for the geonet, provided by the CONTRACTOR to protect the geonet from abrasions, excessive dirt and moisture shall have the following characteristics:
1. level (no wooden pallets)
2. smooth
3. protected from theft and vandalism
4. adjacent to the area being lined.

D. Handling
   1. The CONTRACTOR and INSTALLER shall handle all geonet in such a manner as to ensure it is not damaged in any way.
   2. The INSTALLER shall take any necessary precautions to prevent damage to underlying layers during placement of the geonet.

1.06 WARRANTY

A. Material shall be warranted, on a pro-rata basis against defects for a period of 1-year from the date of the geonet installation.

B. Installation shall be warranted against defects in workmanship for a period of 1-year from the date of geonet completion.

PART 2: PRODUCTS

2.01 GEONET PROPERTIES

A. A geonet shall be manufactured by extruding two crossing strands to form a bi-planar drainage net structure.

B. The geonet specified shall have properties that meet or exceed the values listed In the following table below.

GSE HyperNet

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM AVERAGE ROLL VALUE[c]			
			HyperNet	HyperNet HF	HyperNet HS	HyperNet UF
Product Code			XL4000N004	XL5000N004	XL7000N004	XL8000N004
Transmissivity[a], gal/min/ft (m^2/sec)	ASTM D 4716-00	1/540,000 ft^2	9.66 (2 x 10^{-3})	14.49 (3 x 10^{-3})	28.98 (6 x 10^{-3})	38.64 (8 x 10^{-3})
Thickness, mil (mm)	ASTM D 5199	1/50,000 ft^2	200 (5)	250 (6.3)	275 (7)	300 (7.6)
Density, g/cm^3	ASTM D 1505	1/50,000 ft^2	0.94	0.94	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035	1/50,000 ft^2	45 (7.9)	55 (9.6)	65 (11.5)	75 (13.3)
Carbon Black Content, %	ASTM D 1603, modified	1/50,000 ft^2	2.0	2.0	2.0	2.0
Roll Width, ft (m)			15 (4.6)	15 (4.6)	15 (4.6)	15 (4.6)
Roll Length, ft (m)[b]			300 (91)	250 (76)	220 (67)	200 (60)
Roll Area, ft^2 (m^2)			4,500 (418)	3,750 (348)	3,300 (305)	3,000 (278)

NOTES:

- [a] Gradient of 0.1, normal load of 10,000 psf, water at 70° F (20° C), between steel plates for 15 minutes.
- [b] Please check with GSE for other available roll lengths.
- [c] These are MARV values that are based on the cumulative results of specimens tested by GSE.

C. Resin
   1. Resin shall be first quality, compounded polyethylene resin.
   2. Natural resin (without carbon black) shall meet the following additional minimum requirements:

Table 02621-2

Property	Test Method [1]	Testing Frequencies	Value
Density (g/cm3)	ASTM D 1505	Once Per Resin Lot	>0.94
Melt Flow Index (g/10 min)	ASTM D 1238	Once Per Resin Lot	≤1.0

[1]GSE utilizes test equipment and procedures that enable effective and economical confirmation that the product will conform to specifications based on the noted procedures. Some test procedures have been modified for application to geosynthetics. All procedures and values are subject to change without prior notification.

2.02 MANUFACTURING QUALITY CONTROL

A. The geonet shall be manufactured in accordance with the Manufacturer's Quality Control Plan submitted to and approved by the ENGINEER.

B. The geonet shall be tested according to the test methods and frequencies listed below:

Table 02621-3

Manufacturing Quality Control Test Frequencies			
Characteristics	**Test Method**	**Units**	**FREQUENCY**
			Bi-Planar
Resin			
Polymer Density	ASTM D 1505	g/cm^3	Once Per Lot
Melt Flow Index	ASTM D 1238	g/10 min	Once Per Lot
Geonet Test			
Thickness	ASTM D 5199	mil	1/50,000 ft^2
Carbon Black	ASTM D 4218	%	1/50,000 ft^2
Tensile Strength, MD	ASTM D 4595	lbs/ ft	1/50,000 ft^2
Transmissivity	ASTM D 4716-00	m^2/sec	1/540,000 ft^2

PART 3: EXECUTION

3.01 FAMILIARIZATION

A. Inspection

1. Prior to implementing any of the work in the Section to be lined, the INSTALLER shall carefully inspect the installed work of all other Sections and verify that all work is complete to the point where the installation of the Section may properly commence without adverse impact.

2. If the INSTALLER has any concerns regarding the installed work of other Sections, he shall notify the Project ENGINEER.

3.02 MATERIAL PLACEMENT

A. The geonet roll should be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the ENGINEER.

B. If the project contains long, steep slopes, special care should be taken so that only full-length rolls are used at the top of the slope.

C. In the presence of wind, all geonets shall be weighted down with sandbags or the equivalent. Such sandbags shall be used during placement and remain until replaced with cover material.

D. If the project includes an anchor trench at the top of the slopes, the geonet shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geonet.

E. In applying fill material, no equipment can drive directly across the geonet. The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure.

F. The cover soil shall be placed in the geonet in a manner that prevents damage to the geonet. Placement of the cover soil shall proceed immediately following the placement and inspection of the geonet.

3.03 SEAMS AND OVERLAPS

A. Each component of the geonet will be secured to the like component at overlaps.

B. Geonet Components
   1. Adjacent edges of the geonet along the length of the geonet roll shall be placed with the edges of each geonet butted against each other.
   2. The butted edges shall be joined by tying the geonet structure with cable ties. These ties shall be spaced every 5 feet along the roll length.
   3. Adjoining net rolls (end to end) across the roll width should be shingled down in the direction of the slope and joined together with cable ties spaced every foot along the roll width.
   4. Geonet should be tied every 6 inches in the anchor trench or as specified by the ENGINEER.

3.04 REPAIR

A. Prior to covering the deployed geonet, each roll shall be inspected for damage resulting from construction.

B. Any rips, tears or damaged areas on the deployed geonet shall be removed and patched. The patch shall be secured to the original geonet by tying every 6 inches with the approved tying devices. If the area to be repaired is more than 50 percent of the width of the panel, the damaged area shall be cut out and the two portions of the geonet shall be cut out and the two portions of the geonet shall be joined in accordance with Subsection 3.03.

END OF SECTION

Technical Note

Chemical Resistance Chart

GSE is the world's leading supplier of high quality, polyethylene geomembranes. GSE polyethylene geomembranes are resistant to a great number and combinations of chemicals. Note that the effect of chemicals on any material is influenced by a number of variable factors such as temperature, concentration, exposed area and duration. Many tests have been performed that use geomembranes and certain specific chemical mixtures. Naturally, however, every mixture of chemicals cannot be tested for, and various criteria may be used to judge performance. Reported performance ratings may not apply to all applications of a given material in the same chemical. Therefore, these ratings are offered as a guide only. This information is provided for reference purposes only and is not intended as a warranty or guarantee. GSE assumes no liability in connection with the use of this information.

Medium	Concentration	Resistance at: 20 °C (68 °F)	60 °C (140 °F)
A			
Acetic acid	100%	S	L
Acetic acid	10%	S	S
Acetic acid anhydride	100%	S	L
Acetone	100%	L	L
Adipic acid	sat. sol.	S	S
Allyl alcohol	96%	S	S
Aluminum chloride	sat. sol.	S	S
Aluminum fluoride	sat. sol.	S	S
Aluminum sulfate	sat. sol.	S	S
Alum	sol.	S	S
Ammonia, aqueous	dil. sol.	S	S
Ammonia, gaseous dry	100%	S	S
Ammonia, liquid	100%	S	S
Ammonium chloride	sat. sol.	S	S
Ammonium fluoride	sol.	S	S
Ammonium nitrate	sat. sol.	S	S
Ammonium sulfate	sat. sol.	S	S
Ammonium sulfide	sol.	S	S
Amyl acetate	100%	S	L
Amyl alcohol	100%	S	L
Aniline	100%	S	L
Antimony trichloride	90%	S	S
Arsenic acid	sat. sol.	S	S
Aqua regia	HCI-HNO3	U	U
B			
Barium carbonate	sat. sol.	S	S
Barium chloride	sat. sol.	S	S
Barium hydroxide	sat. sol.	S	S
Barium sulfate	sat. sol.	S	S
Barium sulfide	sol.	S	S
Benzaldehyde	100%	S	L
Benzene	—	L	L
Benzoic acid	sat. sol.	S	S
Beer	—	S	S
Borax (sodium tetraborate)	sat. sol.	S	S
Boric acid	sat. sol.	S	S
Bromine, gaseous dry	100%	U	U
Bromine, liquid	100%	U	U
Butane, gaseous	100%	S	S
1-Butanol	100%	S	S
Butyric acid	100%	S	L
C			
Calcium carbonate	sat. sol.	S	S
Calcium chlorate	sat. sol.	S	S
Calcium chloride	sat. sol.	S	S
Calcium nitrate	sat. sol.	S	S
Calcium sulfate	sat. sol.	S	S
Calcium sulfide	dil. sol.	L	L
Carbon dioxide, gaseous dry	100%	S	S
Carbon disulfide	100%	L	U
Carbon monoxide	100%	S	S
Chloracetic acid	sol.	S	S
Carbon tetrachloride	100%	L	U
Chlorine, aqueous solution	sat. sol.	L	U
Chlorine, gaseous dry	100%	L	U
Chloroform	100%	U	U
Chromic acid	20%	S	L
Chromic acid	50%	S	L
Citric acid	sat. sol.	S	S
Copper chloride	sat. sol.	S	S
Copper nitrate	sat. sol.	S	S
Copper sulfate	sat. sol.	S	S
Cresylic acid	sat. sol.	L	—
Cyclohexanol	100%	S	S
Cyclohexanone	100%	S	L
D			
Decahydronaphthalene	100%	S	L
Dextrine	sol.	S	S
Diethyl ether	100%	L	—
Dioctylphthalate	100%	S	L
Dioxane	100%	S	S
E			
Ethanediol	100%	S	S
Ethanol	40%	S	L
Ethyl acetate	100%	S	U
Ethylene trichloride	100%	U	U
F			
Ferric chloride	sat. sol.	S	S
Ferric nitrate	sol.	S	S
Ferric sulfate	sat. sol.	S	S
Ferrous chloride	sat. sol.	S	S
Ferrous sulfate	sat. sol.	S	S
Fluorine, gaseous	100%	U	U
Fluorosilicic acid	40%	S	S
Formaldehyde	40%	S	S
Formic acid	50%	S	S
Formic acid	98-100%	S	S
Furfuryl alcohol	100%	S	L
G			
Gasoline	—	S	L
Glacial acetic acid	96%	S	L
Glucose	sat. sol.	S	S
Glycerine	100%	S	S
Glycol	sol.	S	S
H			
Heptane	100%	S	U
Hydrobromic acid	50%	S	S
Hydrobromic acid	100%	S	S
Hydrochloric acid	10%	S	S
Hydrochloric acid	35%	S	S
Hydrocyanic acid	10%	S	S
Hydrofluoric acid	4%	S	S
Hydrofluoric acid	60%	S	L
Hydrogen	100%	S	S
Hydrogen peroxide	30%	S	L
Hydrogen peroxide	90%	S	U
Hydrogen sulfide, gaseous	100%	S	S
L			
Lactic acid	100%	S	S
Lead acetate	sat. sol.	S	—
M			
Magnesium carbonate	sat. sol.	S	S
Magnesium chloride	sat. sol.	S	S
Magnesium hydroxide	sat. sol.	S	S
Magnesium nitrate	sat. sol.	S	S
Maleic acid	sat. sol.	S	S
Mercuric chloride	sat. sol.	S	S

- Continued -

Medium	Concentration	Resistance at: 20 °C (68 °F)	60 °C (140 °F)
Mercuric cyanide	sat. sol.	S	S
Mercuric nitrate	sol.	S	S
Mercury	100%	S	S
Methanol	100%	S	S
Methylene chloride	100%	L	—
Milk	—	S	S
Molasses	—	S	S
N			
Nickel chloride	sat. sol.	S	S
Nickel nitrate	sat. sol.	S	S
Nickel sulfate	sat. sol.	S	S
Nicotinic acid	dil. sol.	S	—
Nitric acid	25%	S	S
Nitric acid	50%	S	U
Nitric acid	75%	U	U
Nitric acid	100%	U	U
O			
Oils and Grease	—	S	L
Oleic acid	100%	S	L
Orthophosphoric acid	50%	S	S
Orthophosphoric acid	95%	S	L
Oxalic acid	sat. sol.	S	S
Oxygen	100%	S	L
Ozone	100%	L	U
P			
Petroleum (kerosene)	—	S	L
Phenol	sol.	S	S
Phosphorus trichloride	100%	S	L
Photographic developer	cust. conc.	S	S
Picric acid	sat. sol.	S	—
Potassium bicarbonate	sat. sol.	S	S
Potassium bisulfide	sol.	S	S
Potassium bromate	sat. sol.	S	S
Potassium bromide	sat. sol.	S	S
Potassium carbonate	sat. sol.	S	S
Potassium chlorate	sat. sol.	S	S
Potassium chloride	sat. sol.	S	S
Potassium chromate	sat. sol.	S	S
Potassium cyanide	sol.	S	S
Potassium dichromate	sat. sol.	S	S
Potassium ferricyanide	sat. sol.	S	S
Potassium ferrocyanide	sat. sol.	S	S
Potassium fluoride	sat. sol.	S	S
Potassium hydroxide	10%	S	S
Potassium hydroxide	sol.	S	S
Potassium hypochlorite	sol.	S	L
Potassium nitrate	sat. sol.	S	S
Potassium orthophosphate	sat. sol.	S	S
Potassium perchlorate	sat. sol.	S	S
Potassium permanganate	20%	S	S
Potassium persulfate	sat. sol.	S	S
Potassium sulfate	sat. sol.	S	S
Potassium sulfite	sol.	S	S
Propionic acid	50%	S	S
Propionic acid	100%	S	L
Pyridine	100%	S	L
Q			
Quinol (Hydroquinone)	sat. sol.	S	S
S			
Salicylic acid	sat. sol.	S	S
Silver acetate	sat. sol.	S	S
Silver cyanide	sat. sol.	S	S
Silver nitrate	sat. sol.	S	S
Sodium benzoate	sat. sol.	S	S
Sodium bicarbonate	sat. sol.	S	S
Sodium biphosphate	sat. sol.	S	S
Sodium bisulfite	sol.	S	S
Sodium bromide	sat. sol.	S	S
Sodium carbonate	sat. sol.	S	S
Sodium chlorate	sat. sol.	S	S
Sodium chloride	sat. sol.	S	S
Sodium cyanide	sat. sol.	S	S
Sodium ferricyanide	sat. sol.	S	S
Sodium ferrocyanide	sat. sol.	S	S
Sodium fluoride	sat. sol.	S	S
Sodium hydroxide	40%	S	S
Sodium hydroxide	sat. sol.	S	S
Sodium hypochlorite	15% active chlorine	S	S
Sodium nitrate	sat. sol.	S	S
Sodium nitrite	sat. sol.	S	S
Sodium orthophosphate	sat. sol.	S	S
Sodium sulfate	sat. sol.	S	S
Sodium sulfide	sat. sol.	S	S
Sulfur dioxide, dry	100%	S	S
Sulfur trioxide	100%	U	U
Sulfuric acid	10%	S	S
Sulfuric acid	50%	S	S
Sulfuric acid	98%	S	U
Sulfuric acid	fuming	U	U
Sulfurous acid	30%	S	S
T			
Tannic acid	sol.	S	S
Tartaric acid	sol.	S	S
Thionyl chloride	100%	L	U
Toluene	100%	L	U
Triethylamine	sol.	S	L
U			
Urea	sol.	S	S
Urine	—	S	S
W			
Water	—	S	S
Wine vinegar	—	S	S
Wines and liquors	—	S	S
X			
Xylenes	100%	L	U
Y			
Yeast	sol.	S	S
Z			
Zinc carbonate	sat. sol.	S	S
Zinc chloride	sat. sol.	S	S
Zinc (II) chloride	sat. sol.	S	S
Zinc (IV) chloride	sat. sol.	S	S
Zinc oxide	sat. sol.	S	S
Zinc sulfate	sat. sol.	S	S

Specific immersion testing should be undertaken to ascertain the suitability of chemicals not listed above with reference to special requirements.

NOTES:

(S) Satisfactory: *Liner material is resistant to the given reagent at the given concentration and temperature. No mechanical or chemical degradation is observed.*

(L) Limited Application Possible: *Liner material may reflect some attack. Factors such as concentration, pressure and temperature directly affect liner performance against the given media. Application, however, is possible under less severe conditions, e.g. lower concentration, secondary containment, additional liner protections, etc.*

(U) Unsatisfactory: *Liner material is not resistant to the given reagent at the given concentration and temperature. Mechanical and/or chemical degradation is observed.*

(–) Not tested

sat. sol. = *Saturated aqueous solution, prepared at 20°C (68°F)*

sol. = *aqueous solution with concentration above 10% but below saturation level*

dil. sol. = *diluted aqueous solution with concentration below 10%*

cust. conc. = *customary service concentration*

TN032 R11/13/02

Americas	GSE Lining Technology, Inc.	Houston, Texas	800-435-2008	281-443-8564	Fax: 281-230-8650
Europe/Middle East/Africa	GSE Lining Technology GmbH	Hamburg, Germany		49-40-767420	Fax: 49-40-7674233
Asia/Pacific	GSE Lining Technology Company Ltd.	Bangkok, Thailand		66-2-937-0091	Fax: 66-2-937-0097

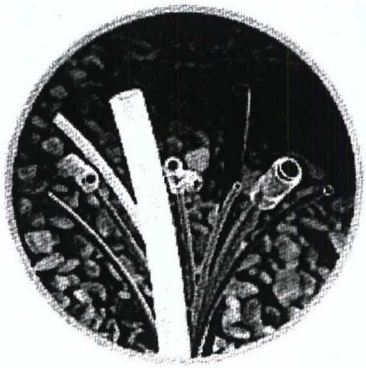
This technical note is also available on our website at:

www.gseworld.com

POLYETHYLENE TUBING MANUFACTURER'S MATERIAL SPECIFICATION

ZELITE(TM)

Back to Tubing & Hose Page



Polyethylene Tubing

- Available in both Low Density and Linear Low Density formulations
- Made from non-toxic ingredients conforming to FDA standards
- Does not impart a taste or odor
- Flexible, lightweight, durable
- Translucent natural or opaque colors
- Made from 100% virgin grade raw materials
- Good dielectric properties
- Low density is listed by the National Sanitation Foundation (NSF 51)
- Linear Low Density offers enhanced resistance to stress cracking
- Chemically inert; forms a good barrier to gases, vapors, and moisture
- Incineration-approved by Scientific Ecology Group (S.E.G.)

Made in U.S.A.

APPLICATIONS

Air Lines • Chemical Lines • Fluid Lines • Food & Beverage • Hospital Uses • Instrumentation • Laboratory Uses • OEM Large Machines • Spacers • Wire Jacketing

Physical Properties**

	Low Density	Linear Low Density
Hardness, Shore D ±5	50	50
Tensile Strength, psi	1600	2250
Elongation at Break, %	500	600
Brittle Temperature	-76°F	-76°F
Vicat Softening Point	201°F	196°F
Max. Operating Temperature	150°F	140°F

**Values listed are typical and are meant only as a guide to aid in design. Field testing should be performed to find the actual values for the application.

Notes

ZELITE conforms to the applicable regulations of the FDA for use of articles intended for contact with food.

FEP-lined polyethylene, offering superior purity at a very reasonable cost, is available through minimum order -- call for details. Low, medium-high and ultra-high density material is available through minimum order. Custom sizes, colors, extruded shapes, repetitive cutting, bonding, heat-formed shapes, and other custom fabrications are also available. Samples of stock material are available upon request.

Corrugated polyethylene tubing is available.

Recommended Fittings & Clamps

- Newloc® Acetal - Push-to-Connect Fittings
- Newloc® Brass - Push-to-Connect Fittings

NEWAGE INDUSTRIES Fluid Transfer Specialists™

%>

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PRODUCT SEARCH

Product Datasheet SEARCH

2500526 -- Zelite LDPE

Product Specifications	
Product Name	Zelite™
Material	Polyethylene
Product Type	LDPE - Low Density Polyethylene Tubing
ID	.170
OD	.250 (1/4)
Wall	.040
Available Lengths	500
Working PSI (at 70°F)	135
Burst PSI (at 70°F)	540
Max Operating Temp(°F)	150
Brittle Temp(°F)	-76
VICAT Softening Temp(°F)	201
Opacity	Opaque
Colors	Black
Construction	Unreinforced
Shore Hardness(±5)	50D
Tensile Strength at Break(PSI)	1600
Elongation at Break(%)	500
Weight (lbs/100 ft)	1.05
Applications	Air Lines, Beverage, Chemicals, Conduit, Food, Hospitals, Instrumentation, Laboratory, Pools & Spas, Potable Water, Spacers, Water & Fluid Lines, Wire Jacketing
Description	LDPE - Low Density Polyethylene Tubing
Material Certifications	FDA, NSF 51

NewAge Industries Fluid Transfer Specialists™

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PRODUCT SEARCH

Product Datasheet	SEARCH

2512104 -- Zelite LLDPE

Product Specifications	
Product Name	Zelite™
Material	Polyethylene
Product Type	LLDPE - Linear Low Density Polyethylene Tubing
ID	.375 (3/8)
OD	.500 (1/2)
Wall	.063 (1/16)
Available Lengths	500
Working PSI (at 70°F)	90
Burst PSI (at 70°F)	360
Max Operating Temp(°F)	140
Brittle Temp(°F)	-76
VICAT Softening Temp(°F)	196
Opacity	Opaque
Colors	Black
Construction	Unreinforced
Shore Hardness(±5)	50D
Tensile Strength at Break(PSI)	2250
Elongation at Break(%)	600
Weight (lbs/100 ft)	3.5
Applications	Air Lines, Beverage, Chemicals, Conduit, Food, Hospitals, Instrumentation, Laboratory, Pools & Spas, Potable Water, Spacers, Water & Fluid Lines, Wire Jacketing
Description	LLDPE - Linear Low Density Polyethylene Tubing
Material Certifications	FDA

GEOMEMBRANE MANUFACTURER'S INSTALLATION QUALITY ASSURANCE AND QUALITY CONTROL MANUALS

QUALITY CONTROL MANUAL
FOR FABRICATION & INSTALLATION OF
PVC AND UltraTech® GEOMEMBRANES

April 1, 2002

The Liner Company

Environmental Protection, Inc.

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Mancelona, Michigan 49659

800-OK-LINER
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or
231-587-9108

Preface

EPI is committed to not only satisfying all appropriate industry and customer specifications, but also continuing to establish new standards of product and service excellence.

Our management and employees regularly assess all aspects of our design, fabrication, shipping, installation and testing procedures to assure we are meeting this commitment.

We are also committed to continuing to be an industry leader in the use of new technology and independent research and development.

The Liner Company

"ENHANCING OUR ENVIRONMENT BY PRESERVING WATER RESOURCES FOR FUTURE GENERATIONS"

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1. SCOPE

This manual presents EPI's basic quality control system for the fabrication, packaging, installation and testing of its polyvinyl chloride (PVC) and UltraTech® liners. As appropriate, the policies and procedures are also applied for projects involving other geomembrane material.

1.01 QUALITY STANDARDS

The products and services of EPI meet or exceed the PVC Geomembrane Institute's PGI-1197 specifications requirements for specified geomembrane liners. EPI's specifications for PVC and UltraTech are included in the appendix.

The testing procedures are consistent with or exceed the requirements of the American Society for Testing and Materials (ASTM) as appropriate.
Laboratory testing equipment is certified and traceable to the standards of the National Institute of Standards and Traceability (NIST).

EPI shall also adhere to the standards as called for in site specific contract plans, specifications and CQC \ CQA documents, consistent with the PVC Geomembrane Institute's PGI-1197 specifications.

1.02 ADHERENCE TO STANDARDS

The procedures herein will be adhered to at all times. The material here supersedes all previous procedures relating to quality control.

The supply and installation of these materials will be in strict accordance with the Engineer's specifications and engineering drawings. Deviation from the standards and procedures described in this manual will only be as required for unique project specifications, according to the terms and conditions of the contract.

Conformance to the established policies and procedures described herein will be monitored by internal audits on a random basis.

1.03 WARRANTIES

EPI will provide the OWNER, as part of the project documents, a specific written warranty. This document will warrant the quality of the PVC geomembrane materials, factory seams and workmanship.

EPI will certify in writing that the installed material meets the requirements of the project and the specification and that, under normal soil covered conditions, the sheet material can be warranted by the material manufacturer for up to twenty years, and that the installation workmanship is warranted for one year.

1.04 DISPOSITION OF SAMPLES AND TESTED MATERIALS

Every sample and test taken, in accordance with the specifications of the installation and the procedures described herein, will consist of two parts:

a) EPI will deliver one part to the OWNER or his representative along with the project documentations, upon the OWNER's written request.

b) EPI will retain and will test and/or archive the other part at its own facility along with EPI's copy of the documentation for the installation.

After testing, all samples, specimens and test reports are the property of EPI.

Additional samples and test material may be taken by EPI for testing at its own laboratory, for its own use and information.

Additional sample and test material may be made available to an independent testing laboratory or the OWNER's representative at the OWNER's expense.

2. IN - FACTORY QUALITY CONTROL

2.01 RAW MATERIALS INSPECTION

a) EPI requires each manufacturer to furnish written certification that all material meets or exceeds EPI's specifications and the PVC Geomembrane Institute's specifications as well as PGI-1197 as appropriate.

b) Prior to factory seaming, all roll goods will be unwound and visually inspected for contaminants, defects, undispersed raw materials and edge uniformity.

c) All defects or impurities will be removed from the roll prior to being fabricated into panels, or the roll will be rejected.

d) Thickness measurements will be made at the beginning and end of each roll of material.

e) Material will be rejected for poor "layflat" edges or "racetracking" caused by inconsistent sheet thickness.

2.02 RAW MATERIALS TESTING

Tests will be conducted by EPI on samples from each 10,000 pound lot geomembrane roll goods material received to verify compliance with the PVC Geomembrane Institute's PGI-1197 specifications in the following areas:

PROPERTY	TEST METHOD
Surface Uniformity	Visual
Thickness (gauge, nominal)	Micrometer-ASTM D-1593
Minimum Tensile Properties (minimum each direction)	
1. Breaking Factor (lbs/in. width)	ASTM D - 882
2. Elongation at Break (percent)	ASTM D - 882
3. Modulus (force) at 100% Elongation (lbs./in. width)	ASTM D - 882

2.03 FABRICATION AND IN - FACTORY SEAMING

The calendered sheets will be factory seamed into maximum sized panels, and custom designed for the specific project so as to minimize field seams. The following practices will be an integral part of the fabrication process:

a) The factory seam process will typically be accomplished by the use of chemical fusion welding. The weld will have a minimum width of one inch.

b) All factory seams will extend to the end of the sheet. No loose edges will be allowed.

c) Each individual strip of material is numbered to correspond with shop fabrication drawings to assure accurate size.

d) Each individual strip is marked at its centerline to assure "square" finished panels.

e) A reinforcing patch is applied to the end of seams in "stepped" panels.

f) Each panel fabricated is logged by serial number, size, date fabricated, material lot number, roll number and fabrication crew.

2.04 FACTORY SEAM REQUIREMENTS

Factory seams for PVC membrane will meet or exceed the following requirements as specified by PVC Geomembrane Institute PGI-1197 :

PROPERTY	TEST METHOD	VALUE
Bonded Seam Strength (factory seam, breaking, lbs/in width)	ASTM D-882 (as modified by PGI)	80% of specified tensile strength
Peel Adhesion (lbs/in width min.)	ASTM D-413	10 Mil - 10 lbs/in width or FTB* 20 Mil - 12.5 lbs/in width or FTB* 30 Mil - 15 lbs/in width or FTB* 40 Mil - 15 lbs/in width or FTB* 50 Mil - 15 lbs/in width or FTB* 60 Mil - 15 lbs/in width or FTB* **FTB = Film Tearing Bond*

Factory seams for UltraTech membrane will meet or exceed the following requirements:

PROPERTY	TEST METHOD	VALUE
Bonded Seam Strength (factory seam, breaking, lbs/in width)	ASTM D-882 (as modified by PGI)	80% of specified tensile strength
Peel Adhesion (lbs/in width min.)	ASTM D-413	10 lbs/in width or FTB* **FTB = Film Tearing Bond*

2.05 IN - FACTORY SEAM TESTING

a) NON - DESTRUCTIVE TESTING
All completed factory seams are 100% visually inspected by two people. Every third seam is visually inspected on both sides. Factory seams will be visually inspected for full seam continuity over their full length during the folding operation by tensioning the seam perpendicular to the seam length. Any areas that do not meet the specified requirements shall be removed and repaired per section 2.05 (c).

b) DESTRUCTIVE TESTING
Destructive tests will be performed to verify that the seam strength requirements of the specifications are met.
Random samples shall be taken at a minimum of every 3,000 lineal feet of factory seam or once per factory panel fabricated, which ever is more frequent, and the following quality assurance tests will be performed on each sample:

- thickness
- bonded seam strength (shear strength)
- peel adhesion

The sample shall be cut into ten one - inch wide specimens. For EPI's standard statistical program, six peel and four bonded seam specimens are removed. Four specimens shall be tested for bonded seam strength (bss) and four for peel adhesion. The additional two peel specimens are used for the Wolschon test specified in 2.07 (see figure 1 in appendix). To be acceptable, the average of four test specimens for peel and the average of four test specimens for bonded seam strength must meet the minimum peak load requirements of factory seams as follows:

Bonded Seam Strength
One-inch strips cut with the weld centrally located are tested by stressing the weld in a "shear" configuration. That is, the top sheet is stressed in relation to the bottom sheet in a direction away from the weld. A pass result occurs when the specimen averages meet the minimum peak load requirements stated in the contract (usually 80% of specified sheet strength). A failure occurs when the weld separates or the material breaks at a peak load less than the minimum requirements. The test result to be reported will be the average of the peak loads recorded for each of the four specimens.

Peel Adhesion
One-inch strips cut with the weld centrally located are tested by stressing the top sheet in relation to the overlapped edge of the lower sheet in an effort to peel the weld away. Each specimen will be peeled two inches along the seam length. A pass result occurs when the specimen meets the minimum peak load requirements stated in the contract. A failure occurs when the weld peels at a peak load less than the specification without film tearing bond. The test result to be reported is the average of the peak loads recorded for each of the four specimens.

Each test will be identified by EPI serial number and the manufacturer's roll number. These tests shall be performed in EPI's laboratory.

Prior to installation of the geomembrane at the site, EPI will provide to the ENGINEER, manufacturer material certifications and/or a copy of quality control test results for all panels to be used, verifying conformance with this specification and the requirements as represented in PVC Geomembrane Institute PGI-1197 specification. The location of any defects and repairs and all necessary retesting results will also be documented in the report.

c) REPAIRS
When a seam sample is removed from the panel being fabricated the resulting hole will be repaired with a patch with a minimum of a one inch bonded area around the patch, and the patch will be rounded on all corners.

2.06 STATISTICAL PROCESS CONTROL (SPC)

EPI follows a consistent Statistical Process Control (SPC) Program of inspection and testing throughout the factory fabrication process. The statistics developed through this program give EPI the ability to interpret information and predict changes needed in the fabrication process before unwanted results occur.

EPI maintains Average and Range (X - BAR - R) process control charts on all results obtained from seam shear and peel tests conducted in EPI's laboratory. The results shown on these charts are reviewed regularly with EPI management personnel, each fabricator, and with the Quality Improvement Team.

EPI maintains histograms of the results of tests performed on samples taken from each lot of geomembrane material received. These tests include visual inspection, thickness, tensile strength, elongation and modulus of elasticity.

EPI's Quality Control Program requires written confirmation of the following, any time a test result is above or below statistical control limits:

- Cause Identification
- Effect Identification
- Corrective Action Taken

EPI's tensile test equipment is re calibrated annually by an independent testing laboratory. The test equipment calibration is verified weekly by EPI.

2.07 Wolschon Testing

A sample is removed from the actual factory fabrication process and, after five minutes, two specimens are tested for peel strength per ASTM - 3083. EPI refers to this procedure as the Wolschon Test, after it's developer Mark Wolschon, EPI's Quality Control Manager. The Wolschon Test data is then compared with previous data in correlation charting with standard ASTM-3083 tests. A direct correlation exists between the peel strength of the Wolschon Test specimens compared to specimens from the same sample tested after forty hours. EPI has established lower limits for Wolschon Test results which will insure minimum 10 lbs/in width peel strength results after 40 hours. If Wolschon Test lower limits are not met, corrective action procedures are in place which will rectify problems before production continues. All test results are analyzed in EPI's statistical process control program.

3. SHIPPING AND HANDLING

3.01 PREPARATION FOR SHIPMENT

a) Factory fabricated geomembrane panels are normally packaged accordion folded on a sturdy wooden pallet designed for fork lift truck access. Smaller panels (i.e. less than 500 lbs.) are rolled on a fiber core, and placed on a pallet.

b) Each panel will be prominently and indelibly marked with the panel size and serial number for proper deployment location according to shop drawings.

c) Pallets have a protective layer (i.e.: cardboard or excess liner) on the surface of the pallet and between the liner and the banding to prevent damage to the liner.

d) All panels will be packaged with a protective, black stretch wrap cover to protect the panel from weather and ultraviolet light.

3.02 TRANSPORTING PANELS TO THE JOB SITE

The geomembrane panels will be packaged and shipped by appropriate means so that no damage is caused. Transportation is the responsibility of EPI, unless otherwise specified.

Materials will be shipped in either a closed trailer or on a flat bed trailer with adequate tarps, and delivered to the site only after the required submittals have been approved and received by EPI from the ENGINEER.

EPI will be responsible for repairing or replacing any material damaged during shipment at no cost to the OWNER.

3.03 UNLOADING

Prior to unloading the geomembrane from the trailer, any obvious damage to the material must be documented on the freight bill by the OWNER.

Any damage during off - loading will be documented by the contractor unloading the material.

Any obvious damage to the material should also be reported to EPI within 24 hours of receiving.

If a forklift is not available, slings should be used to lift pallets off the trailer with a cradle style lift in a way that will not damage the geomembrane material.

3.04 STORAGE

EPI will be allocated sufficient space by the OWNER to store the geomembrane upon its arrival. Proper on - site security is the responsibility of the OWNER.

The panels must remain stored in their original unopened containers in a dry area protected from damage.

Pallets will be stored on a prepared level surface as close to the work area as possible. The pallets should not be stacked.

The geomembrane will be stored so as to be protected from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat, extreme cold or other damage.

If the geomembrane will be installed at ambient temperatures below 60°F, provisions must be made to store the geomembrane in a heated area to maintain the material sheet temperature above 60°F. This storage area should be as close to the installation site as possible.

3.05 ON - SITE HANDLING

On - site handling of the geomembrane is the responsibility of EPI. Appropriate handling equipment will be used when loading or moving the PVC panels from one place to another.

3.06 PALLET PLACEMENT

Pallet placement shall be performed by EPI installation personnel upon their arrival at the job site. Placement of each pallet will be marked with survey flags, according to the shop drawings, by the EPI installation crew.

Pallet placement should be done only after the project area has been measured to assure conformance with the design and the subgrade has been approved by the installation foreman.

3.07 DAMAGED MATERIAL

Any damage to the geomembrane caused by EPI will be carefully documented. If the damaged geomembrane cannot be satisfactorily repaired to comply with the specifications, it will be removed from the work area by EPI and replaced with acceptable geomembrane material at EPI's expense.

4. FIELD INSTALLATION PROCEDURES

4.01 FIELD MEETINGS

a) ON SITE PRE - INSTALLATION MEETING
EPI's field installation foreman will be available to meet with the OWNER, ENGINEER and CONTRACTOR prior to commencement of liner installation. The purpose of this meeting is to:
- Review EPI's responsibilities.
- Review construction schedule.
- Assess any unusual or special requirements

b) DAILY MEETING

A daily meeting will be held at the work area just prior to commencement of the work day. At minimum, the meeting should be attended by the EPI field installation foreman, the INSPECTOR and CONTRACTOR. The purpose of the meeting is to:

- Review the work activity and location for the day.
- Discuss EPI's personnel assignments for the day.
- Review the previous day's activity.
- Review the work schedule.
- Discuss possible problem areas and situations.
- Discuss all safety policies and/or special concerns

4.02 AREA SUBGRADE PREPARATION

a) SUBGRADE

Surfaces to be lined will be smooth and free of all rocks and stones greater than 1/2" diameter, sticks, sharp objects, or debris of any kind. The surface should provide a smooth, flat, firm, unyielding foundation for the membrane with no sudden, sharp or abrupt changes or break in grade.

No standing water, mud, snow and excessive moisture will be allowed. The liner will not be deployed in the presence of mud, snow or frozen subgrade conditions.

The maximum slope for PVC geomembrane should not exceed 3 horizontal to 1 vertical.

If the liner is to be installed at an elevation below the current or possible future ground water elevation, the OWNER will be responsible for providing an adequate underdrain system to prevent ground water pressure beneath the liner. Excessive ground water or gas pressure can force the liner upwards through the cover soil and any liquid contained in the impoundment.

Special care will be taken to maintain the prepared soil surfaces. The soil surface will be observed daily by EPI to evaluate the surface condition. Any damage to the surface caused by weather conditions or circumstances beyond the control of EPI will be repaired by the grading contractor.

b) SUBGRADE CERTIFICATION

EPI will certify in writing that the SURFACE on which the membrane is to be installed is acceptable before commencing work. This certification will not be given until all required soil testing has been completed and approved by the OWNER or ENGINEER. A copy of this certificate is included in Appendix A.

c) SUBGRADE REPAIR

Immediately prior to installation of the designated geomembrane, soil surfaces will be observed by the EPI installation Foreman and the OWNER or his representative. No geomembrane material will be placed on a subgrade that has become softened by water or overly dried until it has been properly reconditioned and/or recompacted. All subgrade repairs required will be performed by the grading contractor.

d) VEGETATION CONTROL

If the OWNER or ENGINEER requires a soil sterilant, the herbicide will not be harmful to the liner and will be applied according to its manufacturer's recommendations. The soil sterilant must be applied at least 48 hours prior to liner installation.

e) ANCHOR TRENCHING

The anchor trench will be excavated to the line, grade and width shown on the construction drawings, prior to liner placement. The OWNER or ENGINEER will verify that the anchor trench has been constructed according to construction drawings.

If the anchor trench is located in a subgrade susceptible to desiccation; no more than the amount of trench required for the geomembrane to be anchored in one day will be excavated to minimize desiccation of the anchor trench soils.

Slightly rounded corners will be provided in the trench where the geomembrane adjoins the trench so as to avoid sharp bends in the geomembrane. No loose soil or rocks will be allowed to underlie the geomembrane in the anchor trench. Leading edges of the anchor trench should be smooth and even.

4.03 LINER PLACEMENT

The EPI installation Foreman shall ensure the following:

a) No equipment or tools will damage the geomembrane by handling, traffic or other means. Clamps and metal tools are padded or have rounded corners and are never tossed or thrown above the geomembrane. Knives and other sharp tools will be carried in protective sheaths.

b) No personnel working on the geomembrane will smoke, wear damaging shoes or engage in other activities that could damage the geomembrane.

c) The method used to unfold the panels will not cause damage to the geomembrane and will not damage the supporting soil or any underlying geotextile.

d) The method used to place the panels will minimize wrinkles (especially differential wrinkles between adjacent panels). Minimum wrinkles will be

allowed to insure the liner is installed in a relaxed condition. Stretching of the Geomembrane will not be allowed.

e) Adequate ballast (e.g., cover soil or similar measures that will not damage the geomembrane) will be placed to prevent uplift by wind. In case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels.

f) Direct contact with the geomembrane by equipment will be minimized, i.e., the geomembrane in traffic areas is protected by geotextiles, extra geomembrane, or other suitable cover materials or cover soil.

g) No vehicles, other than those approved by the installer, are allowed on the geomembrane. Small rubber tired equipment with a ground pressure not exceeding 5 psi, and a total weight not exceeding 750 lbs will normally be allowed i.e., air compressors, generators, etc. that would be required during installation and testing.

h) Seaming adhesives, fusion chemicals, hydrocarbons or chemical cleaning agents are to be stored separately, away from geomembrane panels, and only spill resistant containers should be used while working on the geomembrane.

4.04 WEATHER CONDITIONS

Geomembrane deployment will proceed when ambient temperature and material sheet temperature are between 60°F and 105°F. Sheet temperature will be measured on the membrane surface by an infrared thermometer or surface contact thermometer.

If the soil beneath the geomembrane is frozen, the heat from hot air guns, hot wedge welders or any preheating equipment that may be used can thaw the frost allowing water to be condensed onto the unbonded region ahead of the seam being welded. This possibility may be eliminated by the use of suitable seaming boards or slip sheets made from excess geomembrane. For sheet temperatures below 40°F, shielding, preheating, different chemical compounds and/or a slower seaming rate may be required.

More frequent seam testing and precautions to prevent thawing subgrade may have to be taken. Sharp, frozen subgrade should be avoided to eliminate point pressure damage potential.

Sheet temperatures for seaming should normally be below 105°F (40°C). Depending on material type and thickness, higher temperatures may be allowed. It should also be recognized that wind and cloud cover will determine the actual sheet temperature. For temperatures above this value special attention should be paid to the seaming. The volume of fusion chemical and seaming rate must be adjusted at higher temperatures. More frequent destructive testing may be warranted depending upon field conditions. EPI will discontinue field welding if sheet temperature exceeds 140°F.

If geomembrane deployment is required by the OWNER at ambient temperatures below 60°F, adequate means of storing the liner in an area that maintains the material sheet

temperature above 60°F must be provided. This sheet temperature must be maintained up to the time the liner is deployed. EPI does not recommend deploying or field seaming geomembranes when ambient temperature is below 40°F. However, in special circumstances and with proper preparation, installation can be accomplished at lower temperatures only with the OWNER'S approval of the procedures and any additional costs.

Geomembrane placement will not be done during any precipitation, in the presence of excessive moisture, (e.g., snow, fog, rain, dew, mud) or in the presence of excessive winds, or upon a frozen subgrade, as determined by the installation Foreman.

4.05 UNPACKING THE PANELS

During the unfolding of the geomembrane, EPI will visually inspect each sheet. Damaged or suspect areas will be marked for testing and/or repair. Geomembrane that is damaged during deployment that cannot be adequately repaired will be replaced at EPI's expense.

4.06 PANEL DEPLOYMENT

The number of panels to be deployed in any day will be limited to the number of panels which can be seamed that day. The geomembrane will be placed over the prepared surface in such a manner as to assure minimum handling.

The PVC or UltraTech geomembrane will be installed in a relaxed manner and will be free of tension and stress. Stretching of the membrane material shall not be allowed.

All panels may be repositioned after deployment to meet the overlap requirements; however, deployment and repositioning measures shall not involve dragging or elongating the geomembrane panels.

When possible, the seam overlap should be in the predominant wind direction to reduce wind lift.

4.07 PENETRATIONS

Panels around piping penetrations or other projections through the panel will be cut with rounded corners to prevent tear propagation and ballasted to prevent wind lift until the pipe boot can be installed (see section 4.13).

4.08 FACTORY SEAM QUALITY VERIFICATION

EPI will visually inspect factory seams after the panel is deployed. Additional testing of factory seams in the field will be done at the OWNER'S expense. All factory seams are tested per Section Two of this document.

4.09 FIELD SEAM PREPARATION

A six - inch wide overlap must be cleaned of all dust, dirt or foreign debris no more than 30 minutes prior to applying the chemical fusion agent. Only clean, soft rags will be used for cleaning. If mud has adhered to the sheet surface overlap area, it will be removed with clean water and allowed to dry prior to seaming.

During the cleaning operation, the sheet will be inspected for defective areas which must be removed and/or repaired prior to seaming. The seaming operation requires a solid, smooth subsurface. Subsurface voids, hard nodules, rocks, soft areas or unsuitable conditions will be removed or repaired prior to seaming during subgrade preparation.

Seaming cannot be conducted in the presence of standing water. Wet surfaces must be allowed to dry. A slip sheet or seaming board may be used to lift the geomembrane above damp surfaces. If wind conditions contaminate the seaming area or displace the geomembrane sheets, temporary ballast and additional cleaning procedures will be required.

If weather conditions are not satisfactory, panels will not be put into place. If panels are placed and pulled out, the installation crew will do what is necessary to finish or secure those individual panels that day.

4.10 FIELD SEAMING - CHEMICAL FUSION WELD

All field seams will be a minimum of 2 inches wide. A sufficient amount of chemical fusion agent will be applied that, upon compressing the seam surfaces together, a thin excess of chemical fusion agent will be forced out.

A high durometer rubber, nylon or steel roller will be used to compress the seam surfaces together until a bond is formed. Roller action will be at a parallel direction to the seam's edge so that excessive amounts of chemical fusion agent will be purged from between the sheets.

Trapped chemicals should be rolled out of the seaming area. Care will be exerted in applying the chemical fusion agent.

A continuous wet layer of chemical fusion agent is necessary to prevent a leak at the tie - in point between the last chemical fusion agent application and the next. If the chemical fusion agent, which is initially shiny when applied, takes on a dull filmy appearance, the interfaces may require a faster closing together or the ambient temperature is too high to continue seaming. EPI will monitor this condition at sheet temperatures over 105°F.

At the completion of seaming, all rags, chemical containers, etc., will be properly removed from the geomembrane.

4.11 FIELD SEAMING – THERMAL WELD

EPI has pioneered the methodology and equipment modifications to provide for thermal welding PVC, UltraTech and other thermoplastic geomembranes, especially when ambient temperatures fall below 60F. EPI's thermal welds will meet or exceed the

minimum PVC Geomembrane Institute's 1197 specification for bonded seam strength and peel adhesion. The thermal welding method does not require preheating of the geomembrane prior to welding, provided the sheet is warm enough to be deployed without wrinkles.

The principle of a thermal weld is that both surfaces to be joined come into intimate contact with the heat source between the upper and lower layer of the geomembrane sheet surfaces, melting the surfaces, fusion is brought about by compressing the two melted surfaces together, causing an intermingling of the polymers from both sheets. The heat source itself melts the surface of the viscous polymer sheets, followed closely by the nip rollers which squeeze the two geomembranes intimately together.

Temperature controllers on the thermal welding device should be set according to type of geomembrane, thickness, ambient temperature, rate of seaming and location of thermocouple within the device. Ambient factors such as clouds, wind, and sun require temperature and rate of travel settings to vary. Records for destructive test samples will include the temperature and travel rate settings of the thermal welder used to construct the seam.

It is necessary that the operator keep constant visual contact with the temperature controls, as well as the completed seam coming out of the machine. Occasional adjustments of temperature or speed as the result of changing ambient conditions will be necessary to maintain a consistent seam. Constant visual and hands on inspection is also required.

A five foot test strip will be fabricated and test specimens manually tested prior to constructing each seam, or at any time the seaming procedure (e.g. speed, machine temperature) has changed. A minimum of one test strip will be made each morning and afternoon prior to commencement of welding.

On butt welds across ends of panels, it may be necessary to trim any loose edges of the field seams.

4.12 REPAIRS

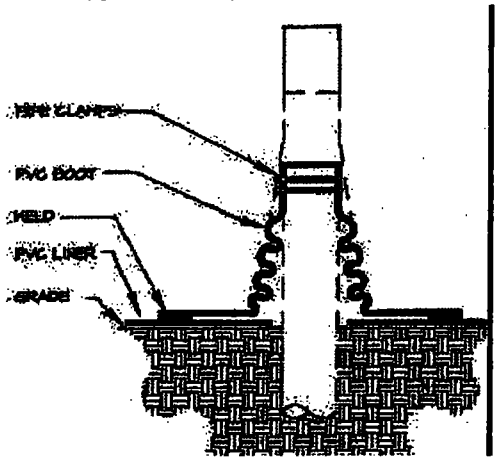
Fish mouths or wrinkles at the seam overlaps will be cut back and overlapped, then patched with an oval or round patch of the same material and thickness as the primary geomembrane.

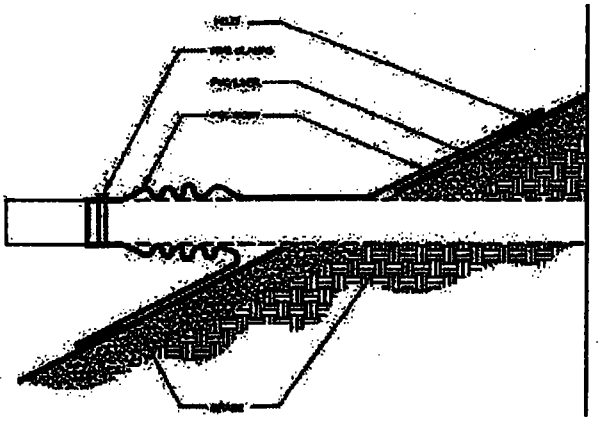
Patches are also necessary where destructive samples are removed or if material is damaged. Patches will extend 6 inches beyond the area to be repaired, be oval or round, and will be chemically welded a minimum of 2 inches around the perimeter.

4.13 TAILORING BOOTS AND SHROUDS

All geomembrane boots and shrouds will normally be of the same material and thickness as the geomembrane specified for the project and will be bonded using fusion chemical, adhesive, thermal weld. All pipe boots will fit snugly without wrinkles or fish mouths.

Unacceptable boots will be replaced or repaired. Geomembrane under the pipe boot must remain in contact with subsurface.





4.14 BOOT INSTALLATION

1) Prepare the subgrade around the area of the pipe. The sub-grade must be smooth, uniform, and free of any protrusions.

2) Clean the surface of the liner around the penetration where the boot will be welded in place. Wipe away any dirt or dust particles. The surfaces of the liner, boot, and the pipe must be completely clean and dry.

3) Slide the boot sleeve on the pipe, making sure the boot is aligned and all surfaces are smooth. It may be necessary to trim the excess tapered portion of the boot sleeve.

4) Weld the boot apron to the liner using EPI provided adhesive. Apply the adhesive to the liner and the boot apron. Let the adhesive setup for several seconds before pressing the boot apron and the liner together using a roller. Make sure to smooth out any bubbles or wrinkles.

5) Seal the boot sleeve to the pipe using the stainless steel hose clamp. The clamp around the pipe will form a watertight seal to the pipe.

4.15 BACKFILLING AND COVERING THE GEOMEMBRANE

The anchor trench will be backfilled and compacted by the contractor as approved by the INSPECTOR. Trench backfill material should be placed in loose lifts and compacted.

The PVC geomembrane must be covered with a minimum of 12 inches of clean soil, free of sticks, stones larger than 1/2 inch diameter, rubbish, or any other material which may

damage the liner. The cover material should be placed over the liner as soon as practical after the liner is installed.

Care should be taken when backfilling the trenches and covering the liner to prevent any damage to the geomembrane or other geosynthetics. At no time will construction equipment come into direct contact with the geomembrane. If damage occurs, it will be repaired by EPI, at the backfilling contractor's expense, prior to the completion and backfilling.

5. CONSTRUCTION QUALITY CONTROL

5.01 FIELD SEAM TESTING

Field Quality Control seam testing involves both non - destructive and destructive testing. The non - destructive testing is primarily centered around determination of "water tightness"; whereas destructive testing is based on ASTM D - 882 and ASTM D - 413 test methods.

The OWNER or his designated representative, have the right of access for inspection of any or all phases of the installation and testing, and to perform additional testing at their expense.

Each seam must be checked visually for uniformity of width and surface continuity. Proper fusion chemical application visually changes the surface appearance. Usually the installer will use an air lance or blunt - end pick to check for voids or gaps under the overlapping geomembrane.

When unbonded areas are located, they can sometimes be repaired by inserting more chemical fusion agent into the opening and applying pressure. If that is not satisfactory, a round or oval patch must be placed over them with at least 6 inches of geomembrane extending on all sides.

Any area of the geomembrane sheets where puncture holes are observed must be patched as above, with at least 6 inches of geomembrane extending beyond the affected areas.

Note that with the above items, it is not practical to use a seaming board or slip sheet beneath the geomembrane. However, a piece of the liner material can be used for added support under the liner, if needed, even if the hole must be enlarged to insert the piece before the patch is made. This added piece is left in place. In either situation, additional care should be used to insure a proper bond.

5.02 NON - DESTRUCTIVE SEAM TESTING

EPI will non-destructively test all field seams over their full length, using an air lance unit. Testing will be performed as the seaming work progresses, not at the completion of all field seaming. This will insure that the covering process can continue while additional liner is installed.

a) AIR LANCE TEST

The air lance will be capable of supplying 50 PSI through a 3/16 inch diameter nozzle. The air stream is directed at the upper edge of the seam no more that 2 inches from the seam edge.

Any voids in the seam will be marked, repaired, and re - tested with the air lance. The EPI testing technician and the Inspector will mark each seam with an indelible marker as accepted immediately after completion of final air lance testing.

b) AIR CHANNEL TEST

For dual track welded seams, the air channel will be sealed at each end and the air channel pressurized with a manometer. Air channel testing will be performed according to ASTM D 5820-95(2001)e1 Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.

Air Channel Test Requirements Per PVC Geomembrane Institute

Geomembrane Thickness	Minimum Pressure lb./in^2	Maximum Pressure lb./in^2	Maximum Pressure drop in 2 minutes lb./in^2
20 Mil	10	20	5
30 Mil	15	25	5
40 Mil	20	30	4
50 Mil	25	35	4
60 Mil	25	35	3

The project ENGINEER will sign EPI's verification of field seam inspections after non - destructive testing and prior to covering the geomembrane.

c) VACUUM BOX TESTING

Vacuum Box testing is not used on PVC or UltraTech® seams.

5.03 DESTRUCTIVE SEAM TESTING

EPI will conduct a minimum of one destructive test per 500 feet of field seam. In order to obtain test results prior to completion of geomembrane installation, samples are cut as the seaming progresses. EPI will mark all samples with their location, panel and seam number. EPI will also record the date, time, name of technicians, ambient temperature and subgrade condition at the time the seam was made. All holes in the geomembrane resulting from obtaining seam samples will be repaired and non - destructively tested.

Any additional destructive testing required by the OWNER or his representative must be requested in writing and will be done at the OWNER's expense.

A copy of the Field Seam Quality Control Record Form is included in Appendix A.

5.04 DESTRUCTIVE TEST PROCEDURES

Samples will be at least 12 inches wide and 12 inches long, with the seam centered lengthwise. If any other samples are required for archive or independent laboratory testing the sample shall then increase in 12 inch increments per sample required. The sample, when larger than twelve inches in the lengthwise direction, shall be divided into equal length pieces One part is to be retained by EPI for testing, any other parts will be delivered to the OWNER or ENGINEER. Additional samples may be added as required for onsite testing with a portable tensiometer.

The sample sent to EPI's lab or any other testing lab will be allowed to acclimate for 40 hours at laboratory temperature (74°F +/- 10°F and 60% +/- 10% RH) prior to testing.

The 12" sample will be cut into ten one - inch wide specimens. Five specimens will be tested for bonded seam strength and five for peel adhesion. To be acceptable, the average of five test specimens must meet the minimum peak load requirements of factory seams as follows:

a) Bonded Seam Strength

One - inch strips cut with the weld centrally located are tested by stressing the weld in a "shear" configuration. That is, the top sheet is stressed in relation to the bottom sheet in a direction away from the weld. A pass result occurs when the specimens meet the minimum peak load requirements stated in the specification (80% of specified sheet strength). A fail occurs when the weld separates or the material breaks at a peak load less than the minimum requirement. The test result to be reported is the average of the peak loads recorded for each of the five specimens.

b) Peel Adhesion

One - inch strips cut with the weld centrally located are tested by stressing the top sheet in relation to the overlapped edge of the lower sheet in an effort to peel the weld away. A pass result occurs when the specimen meets the minimum peak load requirements stated in the contract (10 lbs/in width or FTB). A fail occurs when the weld peels at a peak load less than 10 lbs per inch width without film tearing bond. The test result to be reported is the average of the peak loads recorded for each of the five specimens.

5.05 TEST FAILURE PROCEDURES

The following procedure will apply whenever a sample fails a destructive test. EPI will either:

a) Reconstruct the seam between any two passed test locations, or

b) Trace the seam outward to intermediate points (at least 10 feet from the location of the failed test in each direction) and take a small sample for additional field tests at each location. If these samples pass the field test, a full sample will be cut for verification. The seam is then reconstructed between these two locations. If an intermediate sample fails, the process is repeated to establish the zone in which the seam should be reconstructed. All reconstructed seams must be bounded by two locations from which samples passing other destructive tests have been taken. Over the length of the unacceptable seam (seam between two successful test locations that bracket a test failure), EPI will either cut out the old seam, reposition the panel and re - seam or add a 6 inch *wide* cap strip. In cases exceeding 150 feet of reconstructed seam, a sample taken from the zone in which the seam has been reconstructed must pass destructive testing.

5.06 OWNER APPROVALS

The OWNER or his representative will be notified and requested to witness all non - destructive testing of field seams. EPI will not be prevented from continuing non - destructive testing during normal working hours if the OWNER or his representative declines to witness the testing.

After each field seam has passed the tests described herein, the project ENGINEER is requested to sign an EPI Seam Inspection report on those seams prior to the covering of the geomembrane. The project ENGINEER will be requested to sign EPI's verification of field seam inspections and air lance testing prior to covering the geomembrane.

At the completion of the installation the OWNER or his representative shall confirm in writing that all of EPI's site requirements have been completed as specified.

5.07 DOCUMENTATION

EPI's field installation foreman will maintain a log of each day's work. Included in this log will be:

Date	Ambient temperature
Panels deployed	Weather conditions
Inspections	Field seams constructed
Seaming technicians	Any other site specific conditions

5.08 INSTALLATION ACCEPTANCE

EPI will retain all responsibility for the geomembrane installation until acceptance or covering of the geomembrane by the OWNER or his representative.

The geomembrane liner installation will be accepted by the OWNER or his representative when all of the following conditions have been met:

a) Installation is completed.

b) Verification of the adequacy of all field seams and repairs, including associated testing, as required by the specification, is complete.

c) Sign off, of completed installation, is provided to EPI by the OWNER or his representative.

6. SAFETY POLICY

Environmental Protection, Inc. is committed to the protection of the health and safety of its workers and will take all reasonable measures to achieve this goal. Therefore, the Company is committed to the prevention of personal injury, occupational disease and the protection from accidental loss of all of its resources, including employees, the environment and its physical assets.

In order to fulfill this commitment to protect both people and property, the Company will provide and maintain a safe and healthy work environment according to acceptable industry standards and in compliance with legislative requirements. The Company will strive to eliminate any foreseeable hazards which may result in fires, explosions, security losses, property damage, accidents, personal injuries and/or illnesses.

Environmental Protection, Inc. has the ultimate responsibility to ensure that every reasonable precaution is taken to protect its employees health and safety by working in compliance with the law and with safe work practices and procedures established by the Company.

Managers and supervisors will be held accountable for the health and safety of the employees under their supervision. It is each supervisor's responsibility to comply with, and promote among their workers, the corporate philosophy of health and safety protection and loss control.

In addition to complying with established standards, striving for loss prevention is a company priority objective. Control of losses can only be achieved through the combined efforts of all the employees of Environmental Protection, Inc.. Identification of areas where potential losses may occur is the responsibility of all managers, supervisors and employees. By working together, hazards which have the potential to result in fire, explosions, security losses, property damage or personal injuries / illnesses can be minimized and incidents can be avoided.

6.01 SAFETY AND HEALTH PROGRAM

EPI's comprehensive safety and health program includes:

1. Monthly safety meetings for all employees covering:

   a) Personal Protective Equipment
   j) Lifting Back Safety

b) Hazardous materials "Right to Know"
c) Emergency action plan
d) Lockout Tagout Procedures
e) Blood borne Pathogens
f) Housekeeping
g) Communicable Disease
h) Accident Reporting
i) Fire extinguishers/Fire Prevention, Safety
k) Vehicle & HI - LO Safety
l) OSHA/MIOSHA Inspections
m) Drugs & Alcohol
n) Safety Attitudes
o) Fire Drills
p) Natural Disasters
q) Environmental Emergencies
r) Slips and Falls

2. Specialized training as required, including

a) CPR \ Cardiopulmonary resuscitation
b) First aid procedures
c) Hazardous Materials Handling Training

3. Documented and implemented policies covering:

a) Lockout Tagout
b) Safety Glass Requirements
c) Hazard Communication Plan "Right to Know"
d) Emergency Action Plan
e) General Housekeeping
f) Accident Reporting
g) Right to Know Center "MSDS"
h) Standard Operating Procedures
i) Hazardous Materials List

4. Designated safety program leadership and coordination including:

a) Company Safety Director
b) TQM / Safety team
c) New Employee Orientation
d) Monthly Safety Inspections and follow up
e) Safety Recognition Awards
f) Voluntary Government agency inspections and Environmental testing
g) Preparation and Publication of appropriate safety reports

###

REFERENCES

1. Technical Guidance Document, "Inspection Techniques for the Fabrication of Geomembrane Field Seams", EPA/530/SW-91/051, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C., May 1991.

2. Plastics World, "PVC Geomembranes", Wolschon Test, 275 Washington St., Newton, MA, October 1993.

3. Technical Recourse Document, "Lining of Waste Containment and Other Impoundment Facilities", EPA/600/2-88/052, U.S. Environmental Protection Agency, Risk Reduction Engineering Laboratory, Cincinnati, OH, September 1988.

4. Technical Guidance Document, "Construction Quality Management for Remedial Action and Remedial Design Waste Containment Systems." EPA / 540 / R - 92 / 073, U.S. Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C., October 1992.

5. PVC Geomembrane Institute, Construction Quality Control Document - Dated April 1995.

6. PVC Geomembrane Institute material specification 1197 dated 1-1-1997

7. PVC Geomembrane Institute Technical Bulletin : "New Standards For PVC Geomembranes", August 1997.

8. PVC Geomembrane Institute Technical Bulletin : "Wedge Welding PVC Geomembranes", May 1998

9. PVC Geomembrane Institute Technical Bulletin : "Specification For Thermal Welding PVC Geomembranes", December 1998.

APPENDIX A

The Liner Company

PVC: Polyvinyl Chloride Flexible Membrane Liners

PVC liners fabricated by EPI are a single-ply construction with Polyvinyl Chloride as the principle polymer. Only first quality virgin resins are used and all materials meet or exceed the PGI 1197 Specification for flexible membrane liners.

PVC Liners are fabricated by EPI in panel sizes up to 40,000 square feet, accordion-folded in both directions, and packaged for shipment to your site for quick, easy installation to save you time and money.

EPI utilizes statistical process control (SPC) to ensure the integrity of each panel produced. Samples from actual factory seams are removed during the welding process for a rigorous, proven testing procedure that assures you of the highest quality factory-fabricated PVC geomembranes available.

TYPICAL INSTALLATIONS:

Sewage Lagoons	Canals	Landfills	Decorative Ponds
Reservoirs	Golf Course Ponds	Industrial Waste Ponds	Recreation Ponds
Cooling Ponds	Farm Ponds	Tailings Ponds	Secondary Containment

Applications suggested are not intended to be all inclusive. EPI does not warrant or guarantee the suitability, merchantability, fitness for a particular purpose, or longevity of this material for the uses listed. You may wish to consult your project engineer or installer/contractor to determine what physical properties are required for a synthetic liner. In some cases a chemical compatibility test may be required.

MINIMUM PHYSICAL PROPERTIES:

PROPERTY	TEST METHOD	REQUIREMENTS					
		10 mil	20 mil	30 mil	40 mil	50 mil	60 mil
Thickness	ASTM-D1593	±5%	±5%	±5%	±5%	±5%	±5%
Specific Gravity (min.)	ASTM-D792	1.20	1.20	1.20	1.20	1.20	1.20
100% Modulus (psi, min.)	ASTM-D882	1000	1000	1000	1000	1000	1000
lb. force/in. width, min.)		11	23	34	41	50	60
Tensile (psi, min.)	ASTM-D882	2400	2400	2400	2400	2400	2400
(lb. force/in. width, min.)		25	48	73	97	121	145
Elongation at Break (%, min.)	ASTM-D882	350	350	350	400	425	450
Graves Tear (lb./in., min.)	ASTM-D1004	3.2	6.5	8.5	10.5	13	15
Resistance to Soil Burial	ASTM-D3083						
(% change max.)	(NSF Modified)						
1. Breaking Factor		5	5	5	5	5	5
2. Elongation At Break		20	20	20	20	20	20
3. Modulus at 100% Elongation		20	20	20	20	20	20
Impact Cold Crack (°C)	ASTM D-1790	-23	-26	-29	-29	-29	-29
Dimensional Stability	ASTM D-1204						
(% change/max.)	(212°F/15 min.)	4	4	3	3	3	3
Water Extraction (%, max.)	ASTM D-3083	0.15	0.15	0.15	0.2	0.2	0.2
Volative Loss (%, max.)	ASTM D-1203(A)	1.5	0.90	0.70	0.50	0.50	0.50
Hydrostatic Resistance	ASTM D-751(A)	42	68	100	120	150	180
(psi, min.)							
Minimum Specifications for EPI Factory Fabricated Seams:							
Peel Strength, lbs/in.	ASTM D882	10	12.5	15	15	15	15
Shear Strength, lbs/in.	ASTM D882	20	38.4	58.4	77.6	96	116

These data are based on tests believed to be reliable. However, these are laboratory tests that may not simulate actual use conditions. They are provided for your informational purposes only. No warranty, express or implied, including any other further warranty of fitness for a particular purpose or merchantability, is made by this promotional literature.

The Liner Company

UltraTech® FLEXIBLE MEMBRANE LINERS

The UltraTech flexible membrane liner is a single-ply membrane compounded for hydraulic containment and possessing proven physical characteristics. By virtue of its unique composition, UltraTech offers excellent weatherability, resistance to chemicals, oils, and grease. It is noted for its high tensile strength and elongation properties, as well as its flexibility over a broad temperature range.

In general, UltraTech liners do not require earthen or other cover materials. They are ideally suited for a variety of applications, particularly where resistance to biodegradation and to a wide range of chemicals is advantageous.

UltraTech can be welded directly to a PVC liner, allowing the use of PVC on the pond bottom and UltraTech on the slopes, with no loss of integrity at the connection of the two liners.

CHEMICAL RESISTANCE:

Oil – Excellent	Acids - Fair/very good
Brine - Excellent	Hydrocarbons-Good/Excellent
Solvents - Poor/Fair	Bases - Excellent

TYPICAL INSTALLATIONS:

Canals	Secondary Containments
Brine Pits	Landfill Linings/Covers
Oil Holding Pits	Wastewater Lagoons
Tailing Ponds	Heap Leach Pads
Solar Ponds	Industrial Waste Impoundments

Applications suggested are not intended to be all inclusive. EPI does not warrant or guarantee the suitability, merchantability, fitness for a particular purpose, or longevity of this material for the uses listed. You may wish to consult your project engineer or installer/contractor to determine what physical properties are required for a synthetic liner. In some cases a chemical compatibility test may be required.

UltraTech®

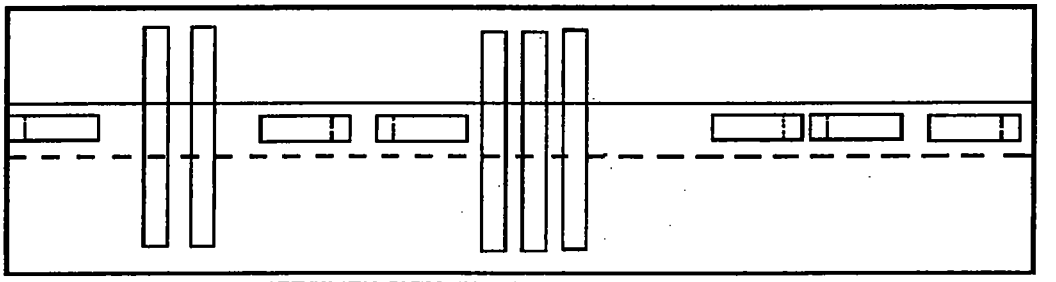
is a registered trademark of Environmental Protection, Inc.

MINIMUM PHYSICAL PROPERTIES:

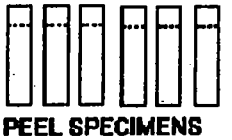
PROPERTY	TEST METHOD	REQUIREMENTS		
		20MIL	30MIL	40MIL
Thickness	ASTM D-2083	±5%	±5%	±5%
Specific Gravity (min.)	ASTM D-792	1.20	1.20	1.20
100% Modulus (psi, min.)	ASTM D-882	900	900	900
Tensile (psi, min.)	ASTM D-882	2300	2300	2300
Elongation at Break (%, min.)	ASTM D-882	290	290	290
Graves Tear (lbs./in., min.)	ASTM D-1004	280	280	280
Resistance to Soil Burial (%change,max.)	ASTM D-3083			
1. Breaking Factor	(NSF modified)	5	5	5
2. Elongation at Break		20	20	20
Impact Cold Crack (°F)	ASTM D-1790	-25	-25	-25
Dimensional Stability	ASTM D-1204			
(%change/max.)	(212°F/15min.)	5	5	5
Water Extraction (%loss,max.)	ASTM D-1239	0.35	0.35	0.35
Volatile Loss (%loss, max.)	ASTM D-1203	1.0	0.8	0.8
Hydrostatic Resistance (psi, min.)	ASTM D-751	55	75	110

These data are based on tests believed to be reliable. However, these are laboratory tests that may not simulate actual use conditions. They are provided for your informational purposes only. No warranty, express or implied, including any other further warranty of fitness for a particular purpose or merchantability is made by this promotional literature.

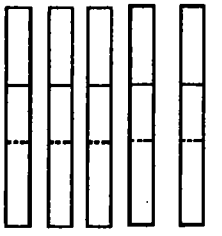
TYPICAL FACTORY SEAM SAMPLE DIAGRAM



SPECIMEN CUTOUT DIAGRAM



PEEL SPECIMENS



BONDED SEAM STRENGTH SPECIMENS

FIGURE 1

Figure 1 is a picture of a typical sample cut from an EPI factory fabricated PVC or UltraTech seam. The sample is 9" X 30" with the seam running lengthwise. On the bottom left are six specimens for testing peel adhesion. One specimen is cut from each end, while four are cut from the center. One inch of peel is initiated on each specimen at the time of fabrication. Each specimen is peeled a minimum of two inches. On the bottom right are five specimens cut for bonded seam strength testing. EPI's samples are cut from actual factory seams at a minimum sampling rate of one per 3,000 lineal feet of seam produced. This is equivalent to approximately each 20,000 square feet of material produced. These samples are tested in EPI's lab and the results are used in EPI's Statistical Process Control Program.

The Liner Company

FACTORY SEAM
Q. C. INSPECTION RECORDS AND SUMMARY
IN-PROCESS INSPECTION AND WOLSCHON TEST

REV 04/01/2002
FORM # Q-112-B

TEST DATE: ___/___/___ FAB DATE: ___/___/___

SERIAL NO.: _____ DESC: _____

JOB NAME : _____

MATERIAL : _____ MANF : _____

SOL APP : _____ ROLLER : _____

TEMP : _____ HUMIDITY : _____%

TIME : ___:___ SHIFT : _____ TABLE : _____

LOT NO.: _____ ROLL NO.: _____

LOCATION OF SAMPLE:_____ FT. ON PANEL _____

SIZE OF PANEL : _____X_____ = _____SQ.FT.

2ND SOL APP : _____ ROLLER : _____

WOLSCHON PEEL TEST

RESULT	TYPE SEP.
_____	_____
_____	_____

SECONDS BETWEEN SOLVENT APPLICATOR & ROLLER: _____

BSS TEST
ASTM D-882 / PGI 1197

DATE TESTED : ___/___/___

RESULT	TEST SPEED	TYPE SEP.
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

PEEL TEST
ASTM D-413 / PGI 1197

DATE TESTED : ___/___/___

RESULT	TEST SPEED	TYPE SEP.
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Type Separation : AD = PEEL AD-BRK = PEEL THEN TEAR BRK = TEAR OR BREAK IN SHEET SE = BREAK AT SEAM EDGE CL = BREAK IN CLAMP

The Liner Company

GENERAL Q. C. INSPECTION RECORDS AND SUMMARY

REV 04/01/2002
FORM # Q-114

TEST DATE: ____/____/____ FAB DATE: ____/____/____

JOB NAME : _____

MATERIAL : _____ MANF : _____

DESCRIPTION: _____

_____

_____

_____

_____

RAW MATERIAL DATA
(MACHINE DIRECTION)

THICKNESS

____ ____ ____ ____ ____

TENSILE

____ ____ ____ ____ ____

MODULUS

____ ____ ____ ____ ____

ELONGATION

____ ____ ____ ____ ____

BSS TEST
ASTM D-882 / PGI 1197

DATE TESTED : ____/____/____

RESULT	TYPE SEP.
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

PEEL TEST
ASTM D-413 / PGI 1197

DATE TESTED : ____/____/____

RESULT	TYPE SEP.
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

RAW MATERIAL DATA
(MACHINE DIRECTION)

THICKNESS

____ ____ ____ ____ ____

TENSILE

____ ____ ____ ____ ____

MODULUS

____ ____ ____ ____ ____

ELONGATION

____ ____ ____ ____ ____

SUBGRADE SURFACE ACCEPTANCE CERTIFICATE

PROJECT NAME: _____

LINER LOCATION: _____

INSPECTION DATE: _____

	Approved	Not Acceptable	Comment
Soil Type	•	•	_____
Soil Moisture	•	•	_____
Uniformity	•	•	_____
Grading	•	•	_____
Rocks	•	•	_____
Roots	•	•	_____
Vegetation	•	•	_____
Rubble	•	•	_____
Protrusions	•	•	_____
Compaction	•	•	_____
Other: _____	•	•	_____

I, the undersigned a duly authorized representative of the OWNER of above mentioned project have completed all required testing on the subgrade and do hearby accept the subgrade surface as being acceptable for placement of the geomembrane liner by Environmental Protection Inc.

_____ _____ _____

NAME TITLE DATE

_____

CUSTOMER SIGNATURE

RECEIVED BY EPI REPRESENTATIVE:

_____ _____ _____

NAME TITLE DATE

_____

EPI SIGNATURE

The Liner Company

FIELD SEAM
C.Q.C INSPECTION RECORD

REVISED 04/01/2002 FORM#Q-113-A

FIELD USE Sample Data

Job Name: _____
Sample location: _____
Installation Date: ____/____/____
Air Temp: _____ Sheet Temp: _____ Humidity: ☐High ☐Med ☐Low
Material: _____ Sol./Welder Opp: _____ Roller/Helper: _____
Weather/ Site/Subgrade Conditions: _____
_____

Field Testing Weld Type: ☐Chemical ☐Adhesive ☐Thermal

Air Lance: Pressure Used: _____ Area tested: _____
Results: _____

Test Strip: Shear _____ _____ _____ _____ _____
Peel _____ _____ _____ _____ _____

Air Channel Pressure Test
Seam ID: _____ Area/Length tested: _____
Start Pressure: _____ End Pressure: _____ Pressure Drop: _____
Time Start: ____:____ Time End: ____:____ Total Time: _____
Results / Corrective action: _____

LAB TESTS

Bonded Seam Test
ASTM D-882 and PGI 1197

Thickness: _____
Test Date: _____

Result	Break Type

Peel Test
ASTM D-882 and PGI 1197

Thickness: _____
Test Date: _____

Result	Break Type		

EPI FIELD SEAM INSPECTION FORM

Project Name: _____

Seam Designation (s): _____

Between Panels: _____

Date Installed: _____

Approved by: _____
(Please Print)

Signature: _____

Company : _____

Date Approved: _____

EPI Technician: _____

The Liner Company

DAILY INSTALLATION QUALITY CONTROL REPORT

Form #H-202
Last Revision 04/01/2002

DATE: ___/___/20____ PROJECT NAME: _____

SUPERVISOR: _____ MATERIAL: _____

S.F. INSTALLED_____ PANEL I.D. NO'S: _____

EPI PERSONNEL: _____ OTHER: _____ TOTAL CREW: _____

START TIME ____:____ FINISH TIME___:___ HOURS WORKED: _____ TRAVEL TIME: _____

EQUIPMENT: _____

SUBGRADE: _____

OTHER JOBSITE CONDITIONS: _____

WORK COMPLETED / COMMENTS & NOTES :

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

TEMP °F : @ START_____ 12:00 PM_____ 3:00PM _____ END_____ WIND VELOCITY: AM_____ PM_____

WEATHER AM : DRY:☐ SUNNY:☐ CLOUDY:☐ RAIN:☐ SNOW:☐ OTHER:_____

WEATHER PM : DRY:☐ SUNNY:☐ CLOUDY:☐ RAIN:☐ SNOW:☐ OTHER:_____

LINEAL FEET OF SEAM COMPLETED: SOLID WEDGE: _____ SPLIT WEDGE: _____

CHEMICAL: _____ ADHESIVE: _____ TOTAL SEAM COMPLETED:_____

LINEAL FEET OF SEAM SIGNED OFF/ACCEPTED BY ENGINEER: _____

OF SEAM SAMPLES CUT FOR DESTRUCTIVE TESTING: _____

SEAM SAMPLE I.D.# (INDICATE FUSION METHOD FOR EACH SAMPLE):_____

_____

EPI SUPERVISOR : _____

The Liner Company

INSTALLATION PROJECT DAILY TIME SHEET

PROJECT : _____ DATE : _____/_____/_____

CUSTOMER : _____ LOCATION : _____

CREW LEADER : _____ MILEAGE : _____

EMPLOYEE NAME	START TIME	LUNCH TIME	QUIT TIME	TRAVEL HOURS	TOTAL HOURS	PER DIEM	EMPLOYEE SIGNATURE

NOTES :

Environmental Protection, Inc.
9939 US 131 South N.E.
Mancelona, Mich. 49659
Ph 800-655-4637 Fax 1-231-587-8020

Change Order

Date: _____/_____/_____ Project: _____

Customer: _____ PO/Contract # _____

Environmental Protection, Inc., is hereby directed to:

- Revise panels and/or specifications as follows: _____

_____

_____

_____

- Stand by at site from _____ to _____ because of:

_____

_____

_____

- Demobilize crew at site effective _____ and remobilize for new schedule start on _____.

- Change project schedule as follows: _____

_____

_____

_____

_____

Authorized Customer Representative

The Liner Company

EPI PVC GEOMEMBRANE LIMITED WARRANTY

Subject to the terms and conditions set forth below, Environmental Protection, Inc. (EPI), warrants that the factory seams of the liner material shown on the reverse of this invoice, if installed in accordance with the manufacturer's specifications and recommendations, shall be free from defects for a period of one (1) year.

The material is warranted by the manufacturer. The manufacturer's warranty shall be the only warranty applying to the material. The warranty of EPI of the seams shall be limited to confinement of an aqueous effluent rated as "excellent" or "A" as set forth in the chemical compatibility list published by the liner material manufacturer.

The warranty is subject to the following:

1. During the period of the one (1) year of which this warranty applies, an earthen cover shall be maintained on top of the liner at all times. The maximum effluent temperature shall not exceed 100° F and the Ph of the effluent shall be maintained between 5 and 9.

2. This warranty shall not cover damage caused by mechanical, physical or other external forces caused by persons or entities other than EPI or damages caused by solutions of greater concentrations than the chemicals as defined below, excessive pressure or stress from any sources or acts of God, casualty or catastrophe, such as, but not limited to, floating debris, insects and animals.

3. This warranty is conditioned upon

   a) normal use and service of the liner for the purpose and in the manner for which it is designed and manufactured;

   b) installation of the liner on preconsolidated soil free of sharp protrusions,

   c) proper field seaming, and installation of the liner material, and

   d) payment in full for all materials and services.

Deviation from any of these conditions shall void this warranty.

EPI guarantees to replace or repair, at its option; defective factory seams caused by poor workmanship for up to one (1) year after the date of the invoice. This warranty is limited to the repair or replacement of the affected membrane area and does not include the cost of earthwork or other activities not originally performed by EPI. **IN NO EVENT SHALL EPI'S LIABILITY EXCEED THE ORIGINAL SELLING PRICE OF THE DEFECTIVE AREA OF THE LINER.**

To enable EPI's technical staff to properly determine the cause of any alleged defect and to take appropriate steps to effect timely corrective measures if such defect is within the warranty, any claim for alleged breach of warranty must be made and presented to EPI within thirty (30) days after the alleged defect was first noticed or all warranties will be deemed to have been waived by the buyer.

During the warranty period, EPI reserves the right to have one or more of its representatives visit (with or without giving prior notice) the site at which its material(s) are being utilized to observe the site preparation, liner installation, emplacement of cover material(s) and/or factory and field seams.

THERE ARE NO WARRANTIES GIVEN BY EPI WITH RESPECT TO THE MATERIAL OR INSTALLATION COVERED HEREBY, OTHER THAN THOSE SPECIFICALLY DESCRIBED HEREIN. THOSE WARRANTIES ARE IN THE PLACE AND STEAD OF THE IMPLIED WARRANTIES OF MERCHANT ABILITY AND FITNESS FOR USE. IN NO EVENT SHALL EPI BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR, RESULTING FROM, OR IN CONNECTION WITH, ANY BREACH OF WARRANTY OR ANY LOSS RESULTING FROM USE OF THE LINER BY BUYER. EPI DOES NOT ASSUME NOR AUTHORIZE ANY PERSON TO ASSUME FOR IT ANY OTHER OR ADDITIONAL LIABILITY OF ANY KIND IN CONNECTION WITH THE SALE OF THE LINER TO THE BUYER OR BUYER'S USE OF THE LINER.

Environmental Protection, Inc.

By: Sample

Authorized Officer

Canadian General-Tower Limited

CANADIAN GENERAL-TOWER LIMITED
CONTAINMENT LINER MATERIAL LIMITED WARRANTY

PROJECT: _____

APPROXIMATE SIZE: _____

INSTALLATION DATE: _____

Canadian General-Tower Limited (CGT) warrants that the liner material to be used in the above referenced project will perform satisfactorily when incorporated into a liner to be used for the containment of the aqueous solution which is defined as follows according to the conditions set forth in any additional pages of the agreement:

CGT further warrants that the material, if properly fabricated and installed, will have a useful service life for a period of 20 years. In addition, the maximum solution temperature is not to exceed __F° and the pH of the solution is to be maintained between 5 and 9.

This warranty does not cover damage caused by mechanical, physical or other external forces or damage caused by solutions of greater concentrations than the one defined above.

This warranty is subject to the following:

1. This warranty is conditional upon (a) normal use and service of the liner for the purpose and in the manner for which it is designed and manufactured, (b) installation of the liner on preconsolidated soil, free of sharp protrusions, (c) proper sealing, fabricating and installation of the liner. Deviation from any of these conditions will void this warranty.

2. CGT shall not be responsible for damage to the liner due to external agents, including but not limited to, damage resulting from exposure of the liner o harmful chemicals; abuse by machinery, equipment or people; excessive pressure or stress from any sources; or acts of God, casualty or catastrophe, such as, but not limited to, unusual storms or other weather conditions, flooding, earthquakes, floating debris, insects or animals.

3. Upon breach of warranty, CGT's sole liability shall be, at its option, either to (a) repair the defective material or (b) supply the owner with repair or replacement material, charging the owner only for a portion of that material (at the then-current price) in proportion to the portion of the ___ year warranty period that has elapsed since the installation date. In no event, however, shall CGT's liability under this warranty exceed an amount equal to the sales price of the defective portion of the liner multiplied by a fraction, the numerator of which shall be the number of years remaining in the ___ year warranty period and the denominator of which shall be ___.

4. To enable CGT technical staff to properly determine the cause of any alleged defect and to take appropriate steps to effect timely corrective measures, if such defect is within the warranty, any claim for alleged breach of warranty must be made and presented to CGT

within 30 days after the alleged defect is first noticed, or all warranties will be deemed to have been waived by the owner.

5. This warranty shall come into effect only upon payment in full to CGT of the purchase price of the original liner material.

6. **THERE ARE NO WARRANTIES GIVEN BY US TO YOU WITH RESPECT TO THE MERCHANDISE COVERED HEREWITH OTHER THAN THOSE SPECIFICALLY DESCRIBED HEREIN. THOSE WARRANTIES ARE IN THE PLACE AND INSTEAD OF THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR USE. IN NO EVENT SHALL CGT BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR, RESULTING FROM, OR IN CONNECTION WITH, ANY BREACH OF WARRANTY OR ANY LOSS RESULTING FROM USE OF THE LINER BY THE OWNER.**

   CGT does not assume nor authorize any person to assume for it, any other or additional liability of any kind in connection with the sale of the liner to the owner or the owner's use of the liner.

CANADIAN GENERAL-TOWER LIMITED
TECHNICAL APPROVAL

BY:_____

TITLE:_____

DATE:_____

CANADIAN GENERAL-TOWER LIMITED

BY:_____

TITLE:_____

DATE:_____

ACKNOWLEDGED AND ACCEPTED

_____

(NAME OF OWNER)

BY:_____

TITLE:_____

DATE:_____

Environmental Protection, Inc.
9939 US 131 South N.E.
Mancelona, Mich. 49659
Ph 800-655-4637 Fax 1-231-587-8020

DATE: _____/_____/_____

PROJECT: _____

CUSTOMER: _____

CONTRACT: – P.O. NUMBER: _____

All the site installation requirements of Environmental Protection, Inc., for the subject project, have been satisfactorily completed

_____
AUTHORIZED CUSTOMER REPRESENTATIVE

GSE Geonets & Geocomposites

Geomembranes ▪ Geonets ▪ Geocomposites ▪ GCLs ▪ Geotextiles ▪ Concrete Protection ▪ Installation Services ▪ Fabrications

Installation Quality Assurance Manual

www.gseworld.com

Table of Contents

I. ROLL PACKAGING AND LABELS

A. GSE geocomposite rolls shall be shipped from the factory in opaque protective covering to prevent damage and UV degradation. GSE geonets do not need to be further protected from UV degradation during shipping or storage.

B. Each roll of GSE geonet and geocomposite are labeled with the following information:

- Name of Manufacturer
- Product Code
- Product Description
- Roll Number
- Roll Dimensions

II. MATERIAL DELIVERY

A. Upon arrival on site, QA personnel will do an inventory of materials on-site.

B. Roll numbers of the geonet or geocomposite will be logged on the Inventory Check List (see Appendix A) and cross-referenced with the bills of lading.

C. Copies of the Inventory Checklist and signed Bill of Ladings should be sent to the home office with on-site QA personnel retaining the originals.

D. Any visible damage to roll materials should be noted on the roll and Inventory Check list.

III. UNLOADING AND STORAGE PROCEDURES

A. Rolls of material shall be unloaded with equipment that will not damage the geonet or geocomposite.

B. Fabric-straps, spreader bars, stinger bars, or other approved equipment shall be used for handling rolls of geonet and geocomposite.

C. Materials should be stored in a flat, dry and well drained area.

D. The surface shall be free of sharp rocks or other objects that could damage the materials.

E. The storage area must be as close as possible to the work area to minimize site handling.

IV. SUBGRADE PREPARATION

The subgrade shall be free of sharp rocks or materials that could otherwise cause damage to the material.

V DEPLOYMENT

Geonet and geocomposite shall be handled in such a manner as to ensure that it is not damaged in any way.

A. On slopes, the material shall be anchored in the anchor trench and then rolled down the slope in such a manner as to continually keep the material under tension.

B. In the presence of wind, the leading edge of the material shall be weighted with sandbags or ballasts until the final cover is placed.

C. Care shall be taken to assure that any underlying layers are not damaged during placement. Low ground pressure machines such as ATV's to facilitate deployment over the geosynthetic layers is recommended. Low ground pressure machines are machines with a ground pressure less than 7 psi when carrying a driver weighing approximately 150 lbs.

D. Care shall be taken to avoid entrapment of stones, mud and other materials during placement and seaming operations.

VI. OVERLAPS AND SEAMS

A. The recommended geonet overlap in the machine direction is 3-inches to 5-inches. The recommended overlap 6-inches to 12-inches in the transverse direction.

B. On slopes the ends of the materials shall be shingled down in the direction of the slope.

C. A plastic cable tie should be placed once per every five linear feet in the machine direction and once per every linear foot in the transverse direction.

D. If the product is a geocomposite, the geotextile on the bottom shall be overlapped and the geotextile on top shall be overlapped, sewn or heat-bonded.

VII. COVER SOIL PLACEMENT

A. Prior to placement of cover soil, a Certificate of Acceptance (see Appendix A) must be signed by responsible party and an installer's representative.

B. Any cover material, such as soil, that is placed over the drainage material shall be placed in such a manner as to assure that it is not damaged.

C. Care shall be taken to minimize any slippage of the geonet or geocomposite and to assure that no tensile stress is induced in the material.

D. Cover soils deployed over the geonet or geocomposite should be free of all sharp objects, such as sharp rocks and sticks.

E. Wide track equipment should be used to distribute cover soil over the geocomposite.

F. A minimum of 12-inches of cover soil is required to separate the equipment from the geocomposite to prevent damage.

Appendix A - GSE Panel Placement Log

Project Name: _____ Site Manager: _____

Location: _____ Product Code: _____

Job Number: _____

Q.A. Tech: _____

Panel Number	Roll Number	Deployment Date	Width (Feet)	Length Feet	Square Feet Smooth	Square Feet Textured

Appendix B - GSE Inventory Check List

Date: _____ Site Manager: _____ Page: _____ of _____

Project: _____ QA Technician: _____

Project #: _____

Row #	Material	Roll#	Used	Material	Roll#	Used	Material	Roll#	Used
A									
B									
C									
D									
E									
F									
G									
H									
I									
J									
K									
L									
M									
N									
O									
P									
Q									
R									
S									
T									
U									
V									
W									
X									
Y									
Z									
AA									
BB									
CC									
DD									
EE									
FF									
GG									
HH									
II									

Appendix C - Certificate of Acceptence

GSE Lining Technology, Inc.
19103 Gundle Road
Houston Texas 77073
800-435-2008
281-443-8564
281-875-6010 Fax

Job No.: _____
Project: _____
Client: _____
Bill To: _____
_____
_____

Job Description: _____
% Complete of Total Job: _____

Certificate of Acceptence

Material	Estimated Square Feet	Final Quantity/Description

I, the undersigned, duly representative of:
Do hereby take over and accept the work described above from the date hereof and confirm to the best of my knowledge the work has been completed in accordance with specifications and the terms and conditions of the contract.

Name	Signature	Title	Date

Certificate accepted by GSE Lining Technology, Inc. Representative.

Name	Signature	Title	Date

GSE

Americas	GSE Lining Technology, Inc.	Houston, Texas	800-435-2008	281-443-8564	Fax: 281-230-8650
Europe/Middle East/Africa	GSE Lining Technology GmbH	Hamburg, Germany		49-40-767420	Fax: 49-40-7674233
Asia/Pacific	GSE Lining Technology Company Ltd.	Bangkok, Thailand		66-2-937-0091	Fax: 66-2-937-0097

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